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Night-time behaviour and interactions between mothers and their infants of low risk for SIDS : a longitudinal study of room-sharing and bed-sharing.

Night-time Behaviour and Interactions between Mothers and their Infants of Low Risk for SIDS: A Longitudinal Study of Room-sharing and Bed-sharing

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Abstract

Infant care practices have proven to be the single most important set of factors for reducing the chances of an infant dying of Sudden Infant Death Syndrome (SIDS). Bed-sharing or 'co-sleeping' is an infant care practice which appears to carry different risks depending upon parental characteristics and the particular sleeping environments in which it occurs. Little is known about how parents care for their babies at night. This study investigated differences in night-time behaviour between mother-infant pairs of low risk for SIDS who habitually bed-shared and those who routinely room-shared, over a period of five months.

Overnight polysomnographic and infra-red video and audio recordings were performed as non-smoking, breastfeeding Caucasian mothers cared for their healthy term infants in a sleep laboratory resembling a domestic bedroom. Five mother-infant pairs routinely bed-shared and five were routine room-sharers. Mothers visited for an initial study night when their infant was approximately four weeks of age and followed their routine sleep practice. The majority returned at monthly intervals for two consecutive nights and were randomised to one night bed-sharing then one night room-sharing, or vice versa. Infant sleep staging was performed off-line and a behavioural code was developed to describe and quantify mother-infant behaviour and interactions.

Clear differences were observed between Routine Bed-Sharers and Routine Room-Sharers. There were differences in the frequency and duration of breastfeeds, the nature of night-time interactions, and the type of bedding chosen and the way it was used. Bed-sharing also had effects on maternal and infant sleep state, and the proximity, body position and physical orientation adopted by mother-infant pairs. No harmful effects of bed-sharing were observed. Studies which aim to investigate bed-sharing must define precisely the conditions under which it occurs. Recommendations regarding bed-sharing should distinguish between the effects of potentially hazardous sleeping environments, and the effects of close contact between mother and baby. Documenting night-time mother-infant behaviour and its effect on infant physiology in a low risk group will form the basis for understanding high risk groups, and may contribute to developing better advice for parents on optimal care practices for their babies at night.

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Author's Declaration

I declare that the work in this thesis was carried out in accordance with the Regulations of the University of Bristol.

The longitudinal study of night-time mother-infant behaviour described in this thesis was conducted by a multi-disciplinary team of clinicians, scientists and researchers based in the Department of Child Health, Bristol. The author, employed as the primary research nurse/associate, has been a main contributor to all aspects of the study. This included helping to plan the methodology and design the data sheets and home and study sleep logs; the recruitment of mother-infant pairs; the performance of the majority of the overnight sleep studies; infant sleep staging off-line using the physiological data recorded; training assistants to supervise the overnight studies, and acting as data manager for the video data collection. The author's main responsibilities have been to develop the behavioural code used in the video data analysis; to carry out analysis of the results with the supervision and assistance of biomedical statisticians; to write up results for reports, abstracts and peer-reviewed published papers; and to present the results at local, national and international meetings and conferences.

This longitudinal study of mother-infant interactions and behaviour was a collaborative effort in which the author played a central role. The research, reviews, video analysis and writing up of this thesis are all the author's own work. Advice from my supervisor and statistical assistance from medical biostatisticians have been sought where appropriate.

The views expressed in this thesis are those of the author and in no way represent those of the University of Bristol.

No part of this thesis has been submitted for any other degree. This thesis has not been presented to any other University for examination either in the United Kingdom or overseas.

SIGNED: Jeanine Young DATE: 17th August 1999

Relevant Publications

Publications that have so far arisen from the work contained in this thesis:

Young, J. (1995) Cot Death Research in Bristol. *NCT: The National Childbirth Trust, Bristol Branch Newsletter* Winter: 14-15.

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Fleming, P.J, Sawczenko, A., Young, J. (1998) Infant sleep physiology: Does mum make a difference ? *Ambulatory Child Health* 4: 153-154.

Young, J. (1998) Babies and Bed-sharing. *MIDIRS Midwifery Digest* 8(3): 364-369

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Blair, P.S., Fleming, P.J., Smith, I.J., Ward Platt, M., Young, J., Nadin, P., Berry, P.J., Golding, J., and the CESDI SUDI Researchers. Where should babies sleep - alone or with parents? Factors influencing the risk of SIDS in the CESDI-SUDI case-control study. (Submitted for publication to the British Medical Journal).

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Pollard, K.S., Leach, C.E.A., Blair, P.S., Sawczenko, A., Young, J., Fleming, P.J. (1997) Does failure to use a soother increase the risk of SIDS ? Epidemiological and Physiological studies. *Pediatric Pulmonology* 24(6): 451.

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Pollard, K.S., Fleming, P.J., Young, J., Sawczenko, A., Blair, P.S. Night-time non-nutritive sucking in infants aged 1 to 5 months. Relationship with infant state, breastfeeding and bed-sharing versus room-sharing. (Accepted for publication in Early Human Development).

Sawczenko, A., Young, J., Fleming, P.J., Galland, B. The effects of bed-sharing upon the environmental conditions during sleep and nocturnal thermal physiology of healthy infants aged two to five months. (Provisionally accepted, Pediatric Research).

Sawczenko, A., Young, J., Fleming, P.J., Galland, B. Variation of night-time infant rectal and peripheral temperatures associated with sleep state, diurnal rhythm, heart and respiratory rates. (To be submitted for publication to Archives of Disease in Childhood).

Dedication

This thesis is dedicated to my son, Daniel Connor, born during this project. Thankyou Dan for the joy you have brought to my life and the firsthand, expert experience you have brought to my research subject.

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'Every part of a system is so related to its fellow parts that a change in one part will cause a change in all of them and in the total system. That is, a system behaves not as a simple composite of independent elements, but coherently as an inseparable whole'.

Watslavick et al., 1967.

Part I

Background

Chapter 1

Introduction

'There is no such thing as a baby, there is a baby and someone'
D.W. Winnicott.

During the past decade, infant care practices have proven to be the single most important set of factors for reducing the chances of an infant dying from the Sudden Infant Death Syndrome (SIDS) (Guntheroth and Spiers, 1992; McKenna, 1996a). In the United Kingdom the best example of this to date is the dramatic fall in the incidence of SIDS over the last seven years since the 'Back to Sleep' campaign in 1991. The rate of SIDS (expressed as 1000 live births) was 1.7 in 1990 and fell to 0.68 in 1993 and 1994, and 0.6 in 1995 (OPCS, 1995).

The main message of this national risk reduction campaign was for parents and caregivers to place infants on their back to sleep. The campaign also included advice for parents not to smoke and to avoid smoky atmospheres; not to let their baby get too hot, and to seek medical advice if their baby was unwell (Department of Health, 1991). The decline in SIDS rate was attributed primarily to the change in advice regarding infant sleep position (Department of Health, 1996). Public campaigns in other countries including Australia, New Zealand, Denmark, Norway, Sweden, Austria, Belgium, West Germany and Ireland (Guntheroth and Spiers, 1992; McKenna, 1996a), in which the supine rather than the prone infant sleep position was recommended, have achieved similar declines in SIDS rates.

Despite an extraordinary amount of world-wide research in recent years, the specific causes of this enigmatic disorder have not been fully understood. There is consensus among researchers that SIDS, or 'cot death' as it is also known, is a multiaetiologic phenomenon, rather than due to a single cause (Fleming and Blair, 1997). Several factors acting together at a vulnerable stage of development, in a predisposed infant, may overwhelm the baby's ability to cope. There are characteristic post-mortem findings, but they are not diagnostic and do not yield an explanation as to why the infant died. The diagnosis is reached by exclusion, by failing to demonstrate an adequate cause of death

(Emery, 1989; Rognum, 1996). In 1994, at the third international meeting on Sudden Infant Death Syndrome held in Stavanger, Norway, a definition of SIDS which addressed the need for a review of the clinical history and circumstances of death, in addition to post-mortem results, was proposed.

Sudden Infant Death Syndrome is:

> 'The sudden death of an infant, which is unexplained after review of the clinical history, examination of the circumstances of death, and post-mortem results' (Rognum and Willinger, 1995, p. 21).

Whilst the cause or causes of such deaths remain unknown, a more precise definition is unlikely to be achieved (Rognum and Willinger, 1995).

Despite the reduced incidence, SIDS remains the largest single group of deaths in infants aged one week to one year of age in the developed world (Fleming, 1995; Wigfield and Fleming, 1995). The Foundation for the Study of Infant Deaths (FSID) has also recently reported that in 1996 the number of cot deaths in the United Kingdom rose for the first time in eight years; an increase of 6% to 0.7 per 1000 live births. The rise is unexplained, however a major possibility is that the 'Reduce the Risk' messages promoted in the 'Back to Sleep' campaign are not reaching parents or carers, or that perhaps there is a false belief that cot death is no longer a problem (FSID, 1998). Continued emphasis of the campaign message and surveillance are required to ensure that the beneficial effects are sustained.

The Department of Health funded a three year case-control study of all sudden unexpected deaths in infancy (SUDI) in three English regions. One of the primary aims of the Confidential Enquiry into Stillbirths and Deaths in Infancy (CESDI) SUDI study was to identify the changing epidemiological characteristics and emerging factors associated with SIDS since the dramatic fall in incidence. The results from the first two years of the study, which included 195 cases and 780 age-matched controls from a birth population of 320,000, were published in 1996 (Blair et al., 1996; Fleming et al., 1996). This study found that previously recognised factors associated with SIDS remained relevant with clear differences between cases and controls. Refinements and extensions to current advice were proposed, and some factors which required further research were identified.

Some features of SIDS remain essentially unchanged. Babies of low birth weight, short gestation (preterm), multiple births and higher birth order, are at greater risk and there remains a preponderance of boys (Department of Health, 1996; Blair, 1998). The majority of deaths occur within the first 8 months of life, with a peak around the third and fourth months. SIDS is more common in babies of younger mothers, and particularly those without a supportive partner. A higher maternal parity (particularly for mothers under the age of 25) and where there was a shorter interval (less than 6 months) between pregnancies also increases the risk (Department of Health, 1996). The previously recognised association between SIDS and socioeconomic deprivation now seems more marked, with approximately 80% of cot deaths occurring in the lower socioeconomic groups. A recent move of house, before, during, or after the pregnancy, has also been identified as a factor in families at a greater risk of SIDS.

The adverse effects of prone sleeping have now been confirmed. A new finding is that the side-sleeping position, previously recommended as a safer alternative, is itself associated with a possible increased risk. Bedcovers such as duvets and quilts, which can easily slip over a baby's head, carry a very high odds ratio (OR 21.58; 95% CI 6.21 to 74.99) (Fleming and Blair, 1997) and are consequently no longer recommended for use for infants under one year. High room temperature, overwrapping, or a combination of both, is associated with an increased risk of SIDS. No independent protective effect from breastfeeding was identified when other significant factors were controlled. Bottle feeding has not been identified as a significant independent risk factor for SIDS, although it was associated with lower socioeconomic status and with smoking. There appeared to be an apparent protective effect with the use of a dummy. However the possibility was raised that the risk may be highest for babies who usually used a dummy but failed to do so on a particular night. A recent report from a large, prospective, population-based study in the United Kingdom showed that pacifier use was associated with a higher risk of symptoms including wheezing, earache, vomiting, fever, diarrhoea and colic, as well as with hospital admission and the general practitioner being called to the home (North et al., 1999). Further research is needed to identify any additional deleterious effects of dummy use, in particular the reported adverse effects on breastfeeding duration (Victora et al., 1993; Ford et al., 1994; Barros et al., 1995). Exposure to tobacco smoke is a strong risk factor both during and after pregnancy. In certain circumstances, especially when the parents had consumed alcohol, were particularly tired, or had taken sleep-enhancing drugs, bed-sharing was shown to be a risk factor, although the findings appear to be restricted to infants of mothers who smoke (Blair et al., 1996; Fleming et al., 1996; Blair et al., in press).

The changes in the epidemiology of SIDS since a risk reduction campaign, identified in the CESDI SUDI study in the United Kingdom, have since been supported by findings from a similar study in New Zealand (Mitchell et al., 1997). In addition to the risk factors already addressed, the New Zealand study also identified room-sharing with parents as being associated with a reduced risk of SIDS (Mitchell and Thompson, 1995). Results from analysis of the third year data set of the CESDI SUDI study, currently in press, also support this finding (Young and Fleming, 1998; Blair et al., in press, Fleming et al., in press).

The majority of deaths attributed to SIDS take place during the night (Department of Health, 1996). Although it is not known whether SIDS occurs during sleep, its association with sleep and the high proportion of time babies spend in sleep during early infancy justify consideration of physiological and behavioural mechanisms operating during sleep (Johnson, 1995). However health professionals have very little direct knowledge of how parents actually care for their babies at night. Virtually all that is known about the normal and abnormal development of infant sleep is based on the western cultural model of the solitary sleeping infant environment: infants sleeping in isolation from their parents or caregivers (Elias et al., 1986; McKenna et al., 1993; Mosko et al., 1997a).

Data from evolutionary (McKenna, 1986; Konner and Super, 1987; McKenna et al., 1990, Trevathan and McKenna, 1994), cross-cultural (Barry and Paxson, 1971; Lozoff and Brittenham, 1979; Morelli et al., 1992) and epidemiological studies (Farooqi et al., 1993; Gantley et al., 1993; Nelson and Chan, 1996) have challenged the assumption that solitary sleeping is the appropriate environment in which to appreciate normal infant sleep. Infant biology has evolved over 4 million years in an environment of close contact with parents throughout the day and night (McKenna, 1986). Interestingly, not one scientific study has documented the presumed socioemotional, psychological, or physiological benefits of solitary infant sleep, except where 'benefits' are defined in terms of parental interests or other cultural values or expectations, or where forms of social sleeping occur under unsafe conditions (McKenna, 1995a). The practice of bed-sharing has also been the subject of much controversy in the literature. In Hong Kong (Davies, 1985; Lee et al., 1989), Japan (Tasaki et al., 1988; Watanabe et al., 1994) and Asian communities in the United Kingdom (Balarajan et al., 1989) where parent-infant bed-sharing is the norm, the SIDS rates are very low. Studies of infant development have also demonstrated beneficial effects of close and almost continuous contact between babies and their caregivers (Reite and Field, 1985; Anderson, 1991; Ludington-Hoe et al., 1992), whilst some studies of unexpected infant death have drawn attention to apparent adverse effects of bed-sharing, particularly among parents who smoke (Scragg et al., 1993; Mitchell and Thompson, 1995).

Extensive studies of the interactions between mothers and their young during sleep have been conducted using animal models. However little is known of the physiological interactions between human infants, the least physiologically mature primates at birth, and their mothers, upon whom there is close and prolonged physical dependence. Anthropological, cross-cultural and preterm physiological studies suggest that infant care practices and the immediate micro-environment may modulate normal infant physiology and development. This has only been widely recognised recently and may have important implications for infant morbidity and mortality. Evidence suggests that some of the epidemiologically identified risk factors for SIDS may exert at least part of their effect by influencing the interactions between mothers and their babies, particularly during times of infant sleep.

At present there is little understanding of what constitutes normal infant sleep in the presence of the mother, how mothers influence nocturnal infant physiology, or the nature of normal mother-baby interactions at night. It is clear that both maternal behaviour and its effects on infant physiology and behaviour should be examined. Given 1) the impact that other environmental and caretaking factors have been found to have on vulnerability to SIDS; 2) the presence of obvious sensory and social differences between solitary and co-sleeping environments; 3) the diversity of forms that co-sleeping can assume; and 4) the fact that neither potentially beneficial or deleterious effects of either solitary or co-sleeping environments have been well delineated, studies which contrast well-defined co-sleeping and solitary sleeping environments and their impacts on infants and their parents are necessary.

McKenna, Mosko and colleagues (McKenna et al., 1990; 1994; McKenna and Mosko, 1994; Mosko et al., 1993; 1996; 1997a; 1997b; 1997c; Richard et al., 1996) have reported several physiological and behavioural consequences of bed-sharing and solitary sleeping in separate rooms.

This thesis will report findings of mother-baby behavioural interactions from a longitudinal, laboratory based study of mother-infant pairs of low risk for SIDS, sleeping either in the same room or the same bed. In this study, polygraphic and infra-red video recordings were made of mother-infant pairs to identify the nature and extent of behavioural and physiological interactions between mothers and their normal infants during times of sleep.

This is the first study to investigate the nature of night-time behavioural interactions between mothers and their babies when they share the same environment and whether behavioural interactions are affected by immediate proximity (i.e. bed-sharing in a double bed), as opposed to sharing a general environment (i.e. room-sharing).

The thesis is divided into four parts:

Part 1 provides an historical review of the social attitudes, cultural practices and medical understanding surrounding childcare practices and the Sudden Infant Death Syndrome up until the present day. A detailed review of the literature on the practice of 'bed-sharing' or 'co-sleeping' will also be presented from evolutionary, cross-cultural and epidemiological perspectives.

Part 2 describes the study design and methodology giving details of sampling methods and the recruitment process. The analytical design of the study is presented together with the hypotheses which have driven the study and the behavioural code which was especially developed for data analysis of night-time mother-baby video recordings. The statistical techniques used and reliability checking of video data are also discussed.

Part 3 presents the results of mother-infant behaviour and interactions from analysis of the video data using the behavioural code. This report focuses on comparisons between environments in which the infants slept, and the effects upon maternal and infant behaviour when bed-sharing and room-sharing.

Part 4 discusses the results presented with regard to the relevance and contribution this study has made to existing knowledge of infant care practices, possible SIDS risk factors and mother-infant behaviour and relationships. A standardised behavioural taxonomy for documenting mother-infant behaviour and interactions is presented in Chapter 9 which may act as a resource for fellow researchers embarking upon similar studies of co-sleeping practices in the home or the laboratory. Areas for further research investigation, and recommendations for parents who wish to bed-share safely, are proposed.

Chapter 2

An Historical Perspective of Childcare Practices, Bed-sharing and their Relationship with SIDS

> 'It is rather unimaginable that separate sleeping arrangements and bedtime problems with children are as old as mankind, and indeed they are not. They are products of our modern civilization'(Luce and Segal, 1966, p.24).

Sudden unexpected deaths in infancy, unexplained by medical science, have been recognised since antiquity. The placing of infants to sleep in cots or cribs is a relatively recent phenomenon, practiced only in the last 200 years, and only western industrialised societies conceptualise this as a normal and desirable sleeping arrangement. Children have slept with their parents since the dawn of mankind, and this practice of bed-sharing or 'co-sleeping' remains today the norm for approximately 90% of the world's population (Mosko et al., 1993).

Whether it is wise for mothers, fathers and babies to share beds has recently been cause for much debate. Does sleeping together protect against SIDS or make it more likely? In New Zealand bed-sharing is specifically not recommended, but many researchers (McKenna, 1986; Farooqi et al., 1993; Gantley et al., 1993; Nelson and Chan, 1996) have brought attention to the fact that cot death is rare in many other cultures where bed-sharing is the norm. Examination of the historical evidence on childcare practices, family sleeping and SIDS shows that the debate is an old and unresolved one. The tendency was to blame the parents when the death of an infant was unexplained.

The notion of overlaying

For many centuries, 'overlaying' was the accepted explanation of sudden and unexpected deaths in infancy, and in some countries legislation was enacted in an attempt to prevent babies being taken into bed with parents, particularly if they had been drinking alcohol (Norvenius, 1993; 1995). The Concise Oxford Dictionary defines *overlay* as 'to smother (a child) by lying on top of' (Allen, 1990, p. 849) and the New Collins Concise English Dictionary as 'to kill (a baby or newborn animal) by lying upon it' (McLeod and Hanks, 1982, p. 806). These definitions appear to be quite straightforward, however comments in a British government debate in 1908 on this issue indicated that

> 'Overlaying was a generic term probably used by medical officers to cover many cases where children were found dead in bed and diagnosis proved somewhat difficult' (Cochrane, 1908 cited by Hiley, 1995a, p. 6).

Sudden infant death syndrome can therefore be considered a modern expression for an old phenomenon, indicating that no known cause for death can be diagnosed despite the modern methods and facilities available (Norvenius, 1995).

<u>Antiquity and the Middle Ages</u>

A biblical quotation from the First Book of Kings in the Old Testament, dating back to 500 BC, is the earliest reference to the overlaying of infants:

> 'And this woman's child died in the night; because she overlaid it' (The Holy Bible, Chapter 3, verse 19, p. 329).

Roman medical text from the 2nd century contains specific advice against overlaying by negligent wetnurses:

> '...the wetnurse should be 'self-controlled' so as to abstain from coitus, drinking, lewdness and any other such pleasure...Besides, the newborn should not sleep with her, especially in the beginning lest unawares she roll over and cause it to be bruised or suffocated. For this reason the cradle should either stand alongside the bed, or if she wants to have the newborn still nearer, the crib should be placed upon the bed..' (Soran from Ephesos, Soranus' Gynaecology, 1956 cited by Norvenius, 1993, p. 8)

As early as the sixth century, overlaying of an infant was regarded by the Irish church as a sin and an offence against the Fifth Commandment, 'Thou shalt not kill'. The church punished the offender but the concept of overlaying meant that the death of an infant was an accident and not an infanticide. The cause was therefore assumed, and not investigated. Norvenius (1993; 1995) provides an historical account of several religious texts, spanning from the 6th to the 14th centuries, which refer to this 'sin' and are primarily concerned with parental punishment:

> 'If any layman or woman overlays his or her child, (such offenders) shall do penance for an entire year on bread and water and for two years more shall abstain from wine and flesh...' (The Penitential of Columban of the Irish Church, circa 600 AD, McNeil and Gamer 1938 cited by Norvenius, 1995, p. 11).

> 'Also, those, who had overlaid their children not by intention but by accident when asleep, have to do penance for three years, if the children were baptised, but have not the children had holy baptism, the time of penance is five years...' (Letter from Pope Alexander III to the Archbishop of Uppsala in 1171, translated by Norvenius, 1993, p. 3).

In England there were also early attempts to influence mothers in their infant care. Since before the Middle Ages, the deliberate suffocation of infants had been common, particularly among the poor in crowded cities. This form of infanticide led local church authorities to make laws forbidding parents to sleep with their infants next to them. The practice of giving infants alcohol and opiates to get them to sleep also became common. Under such conditions, babies often did not wake up and it was presumed that the mothers must have 'overlaid' them (McKenna, 1996b). The Bishop of Lincoln ordered his archdeacons to warn women against 'the careless way in which mothers overlaid their children at night' (Anon, 1905a, p. 126). In 1255 the Bishop of Durham ordered his clergy to exhort mothers not to take their babies to bed with them 'for through this habit many were suffocated' (Hiley, 1995a, p.6). Their health education was unsuccessful because in 1291 mothers were threatened with excommunication if they persisted in sleeping with their infants (Annotations, 1908; Hiley, 1995a). The secular legislation of Sweden in the 13th and 14th centuries regarding overlaying was also influenced by the Canon Law (Norvenius, 1995).

Parent-infant bed-sharing was common during medieval times. Families were often large, and for many, the size of accommodation limited. It was common for the extended family, including aunts, uncles, grandparents, and even servants, to live with the nuclear family. A child in this situation could easily be taken care of by others if his mother was not available (Aries, 1962). 'Kristin Lavrensdatter', an historical novel set in Norway around 1300 A.D., frequently mentions co-sleeping family customs (Thevenin, 1987).

Art has documented the history of the child in medieval times. Until the twelfth century children were rarely depicted as children but as little adults. Early youth was considered a period of innocence that passed quickly and was just as quickly forgotten (Aries, 1962). Around the thirteenth century, children entered family portraits appearing more graceful and picturesque, closer to the modern concept of childhood (Aries, 1962). During the fifteenth century, the 'child' was discovered. From then on, the child became the focus for the first child educators, men who were moralists rather than humanists, to decide in every aspect what was best for children. Youth's innocence was questioned and advice was given that co-sleeping and touching may lead to promiscuity. Girson, the first to propose this 'modern' view according to Thevenin (1987, p. 52), suggested that 'it would be a good thing' for children to begin sleeping apart. He gave no more than a suggestion however, as it was an overall custom for families to sleep together (Aries, 1962; Thevenin, 1987).

Bedrooms as separate sleeping rooms were rare, and the bed was simply regarded as a place to sleep. The bed was usually built into a wall or free standing with a curtain that could be drawn around it (Aries, 1962). During the fifteenth century, the French designed a bed of such beauty that King Louis XII held court from it and issued edicts from his *lit de justice*. The French nobility followed suit and began formally entertaining their guests from high, elaborately canopied beds (Luce and Segal, 1969). The 'Great Bed of Ware', held in the Victoria and Albert Museum in London was reputed to sleep eleven couples in the last quarter of the 16th century (Thevenin, 1987). However among the common people, the bed was often situated in the kitchen or another room in which the daily activities took place. In paintings of 1500-1600, the four poster was often curtained off in the background, with family activity in the foreground (Thevenin, 1987).

The 16th and 17th Centuries

In a study of medical advice on childrearing from 1550 to 1900, Alice Ryerson (Ryerson, 1961) shows that during the 1500's the child's dependency was given considerable encouragement. Mothers were encouraged to breastfeed and the swaddled baby was under constant attention. When a child cried, he was quickly responded to by being picked up, rocked or breastfed. Most children slept with their mothers until they were gradually weaned from the breast at around the age of two. When the child finally moved out of the parents' room, he moved into a bed with his siblings or a servant (Ryerson, 1961). The gradual transition phase of this period closely resembles the cultural practices of most primitive and traditional societies not influenced by western culture, in which there is close mother-baby contact, sensitivity to crying, child spacing, and unrestricted, prolonged breastfeeding with night nursing.

During the sixteenth century the Trinity bed was developed in England. This bed consisted of a large bed upon which the immediate family slept, and two smaller 'trundle' beds which rolled out from underneath. The older children, relatives or servants slept on these (Kenny and Schreiter, 1971 cited by Thevenin, 1987, p.53). In the seventeenth century, the largest of all beds, which could sleep 102 persons, was designed by John Fosbrooke for the royal family. The 'luxury' of separate beds and bedrooms of today was obviously not considered to be a sign of wealth or prosperity at that time (Thevenin, 1987).

Attitudes towards sex varied according to the moral laws of the people. Children under the age of adolescence were believed to be unaware of or indifferent to sex, and this further explains why co-sleeping families did not create problems. Whatever took place was morally accepted, and the children were reared accordingly (Aries, 1962).

Despite the Reformation and the formation of the Protestant churches in Europe in the 16th century, the ecclesiastical right to punish was retained in all churches (Norvenius, 1993; 1995). Swedish clergymen advised parents not to smother their infants when asleep in bed (Norvenius, 1993). During the 17th century, in the era of Protestant orthodoxy, punishments for overlaying were expanded to include fines and excommunication from the church. According to the Swedish Church Law of 1686, if the elders and the clergyman of the parish considered that the infant had been unintentionally overlaid, the mother or both parents were punished by placing them in the pillory at the church entrance. After a public confession, the parents were reinstated into the church and into the community. If the death was considered manslaughter, the secular court sentenced the parents (Thomson, 1960 cited by Norvenius, 1993, p. 12). The Norwegian Law under King Christian V regulated the overlaying of infants in similar ways (Norvenius, 1993; 1995).

Within the field of medical science, Jacques Guillemeau published one of the first European books on pediatric nursing in 1609 which quoted Soran's words warning against negligent wetnurses (Guillemeau, 1609 cited by Norvenius, 1993, p. 4). The French obstetrician Francois Mauriceau reported cases of smothered infants in 1677, similar to modern reports of SIDS (Mauriceau, 1738 cited by Norvenius, 1995, p. 12). A textbook for midwives entitled 'The English Midwife', printed in London in 1682, also warns against the overlaying of infants:

> 'And many (wetnurses), through their intemperancy, by drinking to encrease their milk, and perhaps make it bad enough, sleep so securely and profoundly, that they overlay their Nurseries in the night, and the Children are dead by their sides in the morning. Therefore let nurses sleep so often, that they may hear the latest cry of the infant.' (The English Midwife, 1682 cited by Norvenius, 1995, p. 11).

The 18th Century

During the 18th century a definite change in approach to childrearing and in the sleeping habits of people as a whole was recognised. Thevenin (1987) describes a campaign of propaganda in the 1700's which was launched to try to eradicate the age old custom of sleeping several in a bed. Advice was given that besides the married couple, it was indecent to go to bed with any other person, especially one of the opposite sex. Parents urged children to conceal their bodies from one another and the affluent family began to be concerned with privacy. Houses were built with specific bedrooms, creating places for retreat and isolation (Aries, 1962). Educators, churchmen and other professionals became concerned with the formal and moral education which would be best suited for children, who were viewed as not ready for life without special and proper treatment and education.

Before the steady decline of co-sleeping gained momentum in Europe and America, there was one final resurgence in the form of *bundling*, which became an almost worldwide custom during the period of 1750-1780, and was especially popular in America (Thevenin, 1987). 'Bundling' was defined as a man and woman lying on the same bed with their clothes on, usually covered with a quilt or blanket, conversing or sleeping. The majority of dwellings in the eighteenth century were small, and in the case of American settlers, consisted of one or two rooms in which the family lived and slept. Frequently there were only one or two beds in the house, and the scarcity of fuel was a consideration. It became only common courtesy to invite a visitor, forced to stay overnight, to sleep with the rest of the family. Husbands and parents frequently permitted travellers to bundle with their wives or daughters, even if the husband was not at home. This practice was even accepted among the sex conscious Puritans. The diary of Martha Washington mentions matter-of-factly the number of times she slept with strangers while the President was away (Thevenin, 1987).

In Europe during the 18th century, the overlaying of infants was regarded as a growing public health problem by many scientific academies and became a concern for the secular courts in England. Nursing texts advised against nurses sleeping with their charges:

> 'A Nurfe fhould not take a Child to Bed with her, before he has his Hands and Feet at Liberty; and is able to turn himfelf, for fear fhe fhould happen in a deep Sleep, to lye upon him, or pufh him to the Bottom of the Bed, under the Cloaths, and fo fmother him' (The Nurses Guide, 1729, p. 48).

In 1732, Oliver St John Esquire, a fellow of the Royal Society of London, presented the *arcuccio*, a bed cradle made of wood or iron, designed to protect infants from overlaying or accidental suffocation. The arcuccio had been used in Florence since the 16th century, where infant mortality seemed to be high (Trexler, 1973; Norvenius, 1993; 1995).

> 'Every nurse in Florence is obliged to lay the child in it, under pain of excommunication' (Oliver St John, Esq., The Royal Society of London, 1732, p. 256).

Following the reading of Oliver St John's letter, Swedish engineer Mårten Triewald, instigated national censuses in Sweden which documented population changes and causes of death. These censuses commenced in 1749 and it is possible to compare the rates of overlaying of infants with the infant mortality for the years 1749-1880. In 1749, the Swedish incidence of overlaying was 7.3 per 1000 live births and infant mortality was 209 per 1000 live births (Norvenius, 1993). Although a royal decree was issued in Sweden in 1755 about the benefits of the arcuccio, it was not used by the common people. The arcuccio was however used in the Orphanage of the Free Masons, Göteborg in the 1750's (Norvenius, 1993; 1995). The Royal Danish Academy of Science had a public competition in the 1770's to refine the arcuccio. The winning entry, clinically tested in a Copenhagen maternity hospital, was made of a sheet of metal and could be locked with a padlock. Two German textbooks and an encyclopaedia published in the late 1700's discussed existing knowledge regarding the prevention of overlaying and smothering of infants, and included a description of the arcuccio (Norvenius, 1995).

The 19th Century

During the 19th century marked changes occurred in childrearing practices. During the late 1700's and the beginning of the 1800's, there was a strong religious movement that stressed the importance of personal communication with God and of the Christian perfection of the individual; virtues which depended on self reliance. This quality was believed to be best taught by early independence training (Ryerson, 1961). Bundling was discouraged, attitudes towards sex and touching became laden with sin, and independence of the child was sought. Toilet training was to begin at between three weeks and six months, with the child to be reliably dry at night by the age of three. Punishment was sometimes recommended for failures in cleanliness. All aspects of sexual behaviour in children were strongly forbidden. Medical writers began to emphatically disapprove of rocking, singing, handling, cuddling or responding to a young child's cry (Thevenin, 1987). The newborn was still to sleep with his mother but before the age of one the infant had to be removed from her room to an unshared bed. Feeding schedules were introduced; pacifiers and thumbsucking forbidden, and the age of weaning was reduced to approximately nine months (Ryerson, 1961). The English 'nanny' has also been put forward in the literature as being of great influence in changing childrearing practices in the 1800's, and responsible for many of the sleeping and eating behaviours expected from children today (Thevenin, 1987). These changes in infant care practices are clear trends toward disapproval of dependent behaviour which have lasted well into the 20th century.

With the Industrial Revolution, and later, the improved public transport systems, the extended family began to drift apart. During the 1800's the large family began to be replaced by the nuclear family, in which only the parents and their children lived together. Fewer mothers had aunts or grandmothers to assist in childrearing chores, thus independence of the child became a virtue for practical reasons (Thevenin, 1987).

The advances in scientific knowledge during the eighteenth and nineteenth centuries also had an obvious effect on childcare advice. Doctors realised that certain illnesses were associated with 'dirt' and poor hygiene, although the germ theory of disease was a much later scientific development (Thevenin, 1987). The newly recognised significance of cleanliness has been speculated as possibly leading to the belief that separate sleeping was more hygienic than families sleeping together.

A medical textbook from the early 19th century (DeWees, 1829) suggests that the nursery, (the sleeping quarters for infants and children), should consist of two rooms to ensure ventilation of one room while the other was in use. Pure air was greatly stressed. Further evidence for this view comes from Mrs Beeton's Cookery and Household Management, in which she advises against bed-sharing on the grounds of the possible detrimental effects of gas breathed in by the baby.

> 'The amount of oxygen required by an infant is so large and the proportion of carbonic acid thrown off from both (mother and infant) so considerable that an infant breathing the same air cannot possibly carry on its healthy existence whilst deriving its vitality from so corrupted a medium' (Beeton, 1861, p. 1033).

In addition, Luce and Segal (1969) describe an advertisement for twin beds in a 1893 edition of the Scribner magazine, which read:

> 'Our English cousins are now sleeping in separate beds. The reason: never breathe the breath of another.' (Luce and Segal, 1969, p. 153).

In the early 19th century, the medical profession recognised the causal dilemma created by sudden infant deaths when the civil courts assumed jurisdiction over infanticide. The Births and Deaths Registration Act of 1836 required the certification of the medical cause of death in England and Wales (Limerick, 1992). During the 19th century a realisation grew that infants may die suddenly and unexpectedly without having been exposed to the risk of overlaying (Fearn, 1834). The notion of overlaying subsequently declined, as a new explanation for unexpected death in infancy was proposed. An enlarged thymus, thought to compress the trachea and hinder respiration, was widely accepted in Europe for almost a century as a cause of sudden infant death, although this theory of *status thymico-lymphaticus* was questioned on several occasions (Lee, 1842; West, 1852). The majority of infant post mortems during this time were carried out on infants who had died from malnutrition or infection, and in both of these conditions the thymus becomes involuted and small. The apparently enlarged thymus in sudden death infants was in fact the normal sized gland (Golding et al., 1985). The fallacy of the enlarged thymus continued, despite the statement of the Joint Committee of the Medical Research Council and Pathological Society of Great Britain and Ireland which in 1931 afforded no evidence to this diagnosis for sudden unexpected infant deaths (Young and Turnbull, 1931). Preventative irradiation of the thymus gland was carried out in the 1930's on healthy children, which subsequently caused many to develop carcinoma of the adjoining thyroid gland (Valdes-Dapena, 1995).

During the latter part of the 19th century, other theories began to develop in an attempt to explain sudden infant deaths. Wakely, coroner for Middlesex and editor of the Lancet in 1855, dismissed, except very rarely, the assumption of death from overlaying, and called for thorough investigation by uniform postmortem examinations (Limerick, 1992). He pointed to the preponderance of deaths in the winter months and in the early mornings, especially on Sundays and Mondays. Suffocation, either by accident or intention, was suggested by Tardieu in 1855 (Norvenius, 1995), and in 1857, although permissible with a mother or nurse, bed-sharing with infants was reported as

> 'especially injurious when they sleep with elderly persons, as Dr Roget has clearly proved that, in this case, heat is unduly abstracted from the infant body' (Journal of Public Health and Sanitary Review, 1857, p. 174).

In 1892, Templeman emphasised the poor social conditions in the city of Dundee, which were seen in connection with a large number of infant deaths attributed to suffocation by overlaying. As many as 46% of these deaths occurred on Saturday nights when alcohol consumption was high. Although Templeman concluded that infanticide was unlikely, he suggested that infants should mandatorily 'occupy a separate cot' and recommended that intoxicated parents of dead infants should be prosecuted for negligence (Templeman, 1892). The poor social conditions and the preponderance of deaths in the winter months and in the early mornings, reported in the epidemiology of Templeman's 258 deaths, resembles that of SIDS today. Spasms of the larynx or capillary bronchitis evident only at autopsy were also put forward as possible causes of sudden infant death by Brouardel in 1897 (Brouardel, 1897; Limerick, 1992).

Towards the end of the 19th century, it was clear how overlaying was still regarded by many to be a consequence of moral failing in the parents (Hiley, 1995a). In the children's book *The Water Babies*, the author Charles Kingsley says the water babies are:

> 'All the little children whom the good fairies take to, because their cruel mothers and fathers will not; all who are untaught and brought up by heathens, and all who come to grief by ill usage or ignorance or neglect; all the little children who are overlaid...'(Kingsley, 1863, p. 192).

<u>The 20th Century</u>

Bed-sharing and SIDS

At the turn of this century, most unexpected deaths were still attributed to overlaying and certain factors associated with these deaths began to be recorded in the literature. The previously recognised seasonal distribution in deaths attributed to overlaying was thought to be due to the increased likelihood of babies sleeping in their mothers' beds for winter warmth (Brend William, 1915 cited by Limerick, 1992). Young maternal age, single motherhood, and errors in feeding appeared in the literature in connection with infant death (Willcox, 1905), and low socioeconomic status was thought to be associated with an increased likelihood of sudden unexpected infant death (Anon, 1905a). Overlaying deaths occurred twice as frequently on a Saturday and in weeks which included a Bank Holiday (Annotations, 1908; Hiley, 1995a). The weekend deaths supposedly reflected the increased likelihood of alcohol ingestion and episodes of drunkenness which appeared frequently in discussions on overlaying (Hiley, 1995a). Interestingly, a modern study examining the epidemiology of SIDS also found a significant excess of deaths at weekends among older infants, which increased from Monday to Sunday (Murphy et al., 1986). This report found no association with the day of the week for younger infants, and suggested that a change in routine or hesitation in calling the doctor might explain the excess of deaths at weekends. The Victorian and Edwardian British press held the erroneous belief that it was an English habit to have a child in bed with the parents (Anon, 1905a). France and Germany were thought not to suffer overlaying deaths. This may be the first recognition that culturally determined patterns of infant care could influence mortality. Apparently French and German mothers, unlike the British, never became drunk either! (Wynn Westcott, 1903; Hiley, 1995a).

During the early 20th century, as detailed post mortem examinations became more common, overlaying was no longer assumed as a causal explanation for sudden unexpected infant death. In 1915, a coroner named Brend William who was particularly keen on good post mortem examinations, published statistics from deaths attributed to violence and unnatural causes in the United Kingdom.

> 'Figures appear to show that in the districts where the proportion of post mortems is high, and where they are conducted by expert pathologists, very few cases of deaths attributed to overlaying occur' (Brend William, 1915 cited by Limerick, 1992, p. 4).

However there was still concern about preventing deaths from overlaying, and parents were actively encouraged to sleep their infants separately from the parental bed. In 1904, following the review of infant mortality statistics, Willcox noted:

> 'It seems certain that amongst the poorer classes of the crowded districts of London and many of our great towns, the cradle or cot for the young infant is practically unknown' (Willcox, 1904, p. 1).

The special provision of cots was suggested. Some thought this would be too expensive, but others disagreed:

> 'As to the difficulty of obtaining cots for the very poor, a drawer placed on two chairs, an orange box, or a clothes basket will make a fairly efficient substitute' (Anon, 1905b, p. 660).

Even then however, there was some question about possible consequences arising from the widespread use of cots:

> 'The lowering of vitality from cold, with probably also an unsatisfactory food supply that would result from the use of cots, would bring about greater evils than those ensuing from infants being in bed with their mothers' (Anon, 1905b, p. 660).

The practice of cots was slowly adopted, yet infant deaths still occurred. Despite this, attempts to influence infant care were enshrined in law after a great deal of public debate. In the Children's Act of 1908 (The Law Reports, 1908) it became an offence in Britain for an adult to have slept, while under the influence of alcohol, with a child under the age of three, who is subsequently found dead (Chapter 67, Part 1, Section 13). The law was inadequately framed and no convictions resulted, although the clause on alcohol and bed-sharing was repeated in 'The Children's and Young Persons Act of 1933' in Chapter 12, Part 1, Section 1-2b (The Law Reports, 1933), and remains on the statute books in England and Wales to this day.

During the 1920's other explanations for sudden unexpected deaths were proposed. The first description of silent attacks of arrested breathing (sleep apnoea) in healthy infants came from Still in London in 1923 (Still, 1923), and in the USA, fulminating infection by Streptococcus haemolyticus was proposed by Farber as a cause in 1934 (Farber, 1934). Despite these theories, until the mid 1940's, the majority of unexplained infant deaths were registered as 'accidental mechanical suffocation' attributed to bedding and sleeping attire (now that infants seldom shared the parental bed); status thymico-lymphaticus, or inhalation of vomit (Limerick, 1992).

In the mid-1940's pathologists began to question accidental mechanical suffocation as a cause of these unexplained infant deaths due to the lack of evidence of suffocation at autopsy (Davison, 1945; Woolley, 1945; Werne and Garrow, 1947) and the view that parents should not be held responsible for the death of their baby, especially when the diagnosis was not conclusive (Woolley, 1945). Many unexpected infant deaths initially attributed to suffocation were shown, after skilled post-mortem examination, to be due to natural causes such as acute tracheobronchitis or bronchopneumonia, sometimes associated with otitis media. Pathologists began to attribute such deaths to respiratory diseases to spare parents the ordeal of an inquest which would necessarily follow an unnatural death (Limerick, 1992). Interestingly, some of the characteristics of infant deaths described by Abrahamson (1944) and recorded as accidental mechanical suffocation between 1939 and 1943 in New York display a striking resemblance to the epidemiological characteristics of SIDS infants today. Three quarters of the deaths occurred between 2 and 5 months, median age 2-3 months; there was a preponderance of males; more deaths occurred in the winter; 68% slept prone, and most families were from the lower socioeconomic groups.

In the 1950's an infant dying suddenly and unexpectedly from no known cause became accepted by the medical and scientific establishment. The term cot death was first used by a pathologist named Barrett, in 1954.

> 'The term cot death is used here to include all cases in which an apparently healthy infant is unexpectedly found dead in its sleeping quarters, whether in a cot, pram or other kind of bed' (Barrett, 1954, p. 301).

In the next decade, research into this phenomenon greatly expanded. In 1965 the final report of an investigation into sudden deaths in infancy in England and Wales reported that there was some evidence for each of the three hypotheses: infection, suffocation and hypersensitivity to cow's milk protein, which may have played a part, either singly or in combination, in cases of 'unexplained' infant deaths (Department of Health, 1965). The term 'sudden death' (cause unknown) was first included as a separate category in the International Classification of Diseases (ICD 795) at the time of the eighth revision in January 1968, and amended eleven years later in the ninth revision when the term 'sudden infant death syndrome' was introduced (Limerick, 1992).

Two international conferences were organised in Seattle in 1963 and 1969 to address what was known about the aetiology of SIDS. A working definition of 'sudden infant death syndrome' was derived from the second of these conferences:

> 'The sudden death of any infant or young child, which is unexpected by history, and in which a thorough post-mortem examination fails to demonstrate an adequate cause of death' (Beckwith, 1973, p. 1).

A degree of diagnostic stability and focused research was achieved with this definition. During the last twenty years, researchers in the fields of pathology, physiology, epidemiology, and prevention have attempted to prove or disprove a plethora of hypotheses, and to answer key questions about developmental maturation and potential vulnerability. A few causes, including infant botulism (Arnon, 1978) and inherited metabolic disorders (Howat et al., 1984), have been identified which accounted for a small proportion of previously unexplained infant deaths.

Physiological research has focused on the development of infants in the first six months of life, their respiratory control, maturational changes in heart rate and rhythm, the development of electrical activity of the brain, and sleep state organisation in relation to thermal environment, nutrition and infection. This research has begun to identify periods, characteristics, and circumstances of potential vulnerability (Limerick, 1992; Valdes-Dapena, 1995).

Publication and presentation of research findings at national and international meetings have enabled collaboration between doctors, scientists and statisticians and have allowed comparison of epidemiological data between regions of high and low incidence. No specific advice could guarantee against cot death, but in the late 1980's and 1990's general advice could be given on infant care practices to reduce the risk of SIDS. Public campaigns in the late 1980's and early 1990's in the Netherlands, Australia, New Zealand, Denmark, Norway, Sweden, Austria, Belgium, West Germany, Ireland and the United Kingdom (Guntheroth and Spiers, 1992; McKenna, 1996a), to encourage parents to lay infants on their back or side to sleep, to avoid smoking and smoky environments, to prevent infants from becoming too hot, and to contact a doctor if the baby is unwell, have had dramatic results in reducing the incidence of SIDS. To date, there is no published evidence of any increased risk of SIDS associated with bed-sharing in infants of parents who do not smoke, and who have not consumed alcohol or other drugs (Young and Fleming, 1998).

Much of the literature regarding the safety of the practice of bed-sharing has been related to research which has investigated risk factors associated with Sudden Infant Death Syndrome. Sudden and unexpected infant deaths, unexplained by medical science, have occurred throughout history. Although it is not possible to connect conclusively the ancient notion of overlaying or the 19th century theory of status thymico-lymphaticus with SIDS of today, it is plausible that the concepts are firmly related. SIDS is, therefore, not a new phenomenon.

Childbirth, infant care practices and bed-sharing

Around 1900 almost all births still occurred at home with the midwife, husband and sometimes other family members in attendance. By 1940, most mothers delivered in hospitals, and the custom of separating mother and child at birth began, presumably because many mothers, drugged during labour, were not capable of caring for their babies immediately postpartum. The hospital nursery was instituted (Wessel, 1972; Thevenin, 1987). The historical process whereby childbirth was transferred from the private home to the public domain of the hospital; from its management by experienced women and midwives to control by predominantly male professionals; and from it being a 'natural', biological and cultural event to a highly medical, technological one, has been well documented (Tew, 1990; Kitzinger, 1992; Oakley, 1993; Young, 1995). This process was a result of several factors.

Traditionally women have always had a key role to play in the delivery of children, and few societies have been without midwives of one kind or another. The nineteenth and twentieth centuries saw the rise of male-dominated medical specialties such as obstetrics. In Britain and the USA, these male physicians generated controversy as they took over from midwives, insisting that the rigours of childbirth necessitated the surgical and medical interventions that only they could make. Maternity care in economically developed countries, with the exception of the Netherlands, became organised so as to give full effect to the theory that childbirth is always safer if it takes place under the management of obstetricians in a hospital provided with the technological equipment for carrying out interventions in the natural process (Oakley, 1993; Young, 1995). Obstetricians have constantly warned that no delivery is normal until it is completed and, backed by successive government and other committees, have striven towards 100% hospital delivery, preferably in large units. This view pathologises a normal process and has contributed to the profound medicalisation of childbirth (Tew, 1990; Oakley, 1993; Young, 1995). For example, in Britain in 1927, 85% of all children were born at home, but by 1980 this proportion had fallen to just over 1%. In 1953, the caesarean section rate was 2.2%, with 3.7% of children born by forceps or vacuum extraction. By 1984, caesarean rates had risen to 10%, and instrumental deliveries to 15% (Aggleton, 1990).

Health care reforms in Britain during the early 20th century also had an effect on the general shift from home to hospital deliveries. In Britain before 1900, most users of health care had to pay for their own intranatal care. The richer population could afford to buy the services of doctors with the possibilities of instrumental delivery and anaesthesia. The less rich were deprived of this apparent luxury, a deprivation which Tew (1990) argues was a benefit, although not widely accepted at the time. After 1900, with the development of modern health policies, such as the 1911 National Insurance Act which introduced sickness and unemployment benefit, and free general practitioner care for those on low incomes; and the creation of an integrated system of hospital and primary medical care by the Davidson Committee in 1919 (Aggleton, 1990), provision for the poor became part of the national agenda. Free antenatal care in municipal clinics, more midwives, and more maternity beds in municipal hospitals became available through community taxes paid to local authorities. However, the unwelcome stigma of poverty attached to these free provisions deterred many women from using them. Health reforms leading up to, and including, the foundation of the National Health Service in 1948 swept aside the stigmatisation of free provision for some by making maternity care free to all (Aggleton, 1990; Tew, 1990). Medically organised care was accepted as being so advantageous to welfare that financial cost was no longer the limiting criterion. Doctors were given a generous budget to organise the service as they thought best, and obstetricians thought the extension of hospital facilities was the way forward (Tew, 1990).

The professional bias of obstetricians and their medical colleagues, not surprisingly, was to attribute the decline in associated mortality and morbidity to their efforts, including safer hospital deliveries and better hygiene practices. However it has been well documented that perinatal and maternal morbidity rates improved regardless of medical innovations with the rising standard of living; especially improved nutrition, water supplies and sewage disposal. Mortality began to decline long before the causal organisms of many infectious diseases became known and medically treatable, with the decline in tuberculosis deaths between 1840 and 1870 a clear illustration of this (Tew, 1990; Oakley, 1993).

‘Where to be born? The debate and the evidence’, a report published in 1987 by the National Perinatal Epidemiology Unit examined the results of delivering women in different places over the past century. The most significant conclusion from this report was the lack of evidence to support the claim that the safest policy was for all women to give birth in hospital. The report also suggested that there was some evidence, although not conclusive, that morbidity was higher among mothers and babies cared for in an institutionalised setting. For some women, the iatrogenic risk associated with institutionalised delivery may have been greater than the benefit concurred (Campbell and MacFarlane, 1987). There is also evidence to suggest that birth is safer the less it is interfered with (Tew, 1990). Interventions which undoubtedly benefit a minority of mothers, and which are probably life-saving in certain, but infrequent, obstetric emergencies, have been applied to the majority who do not need them (Tew, 1990; Oakley, 1993). In fact, many interventions, undertaken ostensibly in the interest of the infant, were introduced and adopted as routine practice without systematic evaluation of their effectiveness (Tew, 1990; Oakley, 1993; Young, 1995).

Many authors have argued that this technological era in obstetric care which developed during the 20th century has led women to believe that having a baby is a dangerous and complicated affair, which in turn has encouraged their dependence and undermined their confidence in themselves as reproducers and mothers (Tew 1990; Kitzinger, 1992; Oakley 1993; Young, 1995). It has long been acknowledged that the experience of childbirth may affect women and their developing relationships with their children and other family members for the rest of their lives (Kitzinger, 1992; Oakley, 1993). It is therefore probable that the medicalisation of childbirth, and its subsequent effects on mothers and their families, have been influential factors in childcare practices.

Towards the middle of this century, women’s magazines, books on childrearing, and the family paediatrician or general practitioner gradually took over the role of giving advice that mothers and relatives had previously occupied (Kitzinger, 1992). Behavioural psychologists viewed the development of the child as shaped entirely by the habits he acquired through contact with his environment (Thevenin, 1987). Emphatic advice was given that in order to assure the child’s development of independence, the mother should not rock, cuddle, or kiss their babies too much. In the mid 1900’s a childcare book by Dr

Emmett Holt was recommended for mothers in the USA. Advice in this text included that babies should sleep alone in their own room and should not be picked up when crying unless there was a noticeable reason, to avoid 'indulging' the infant. Discipline was best started in the first few weeks of life (Holt, 1943). Breastfeeding was replaced by bottle feeding, cribs replaced the family bed, and playpens and strollers replaced parental arms. Strict schedules were implemented for the feeding and caring of infants (Thevenin, 1987).

Medical advice during the early 1900's emphasised the idea of separate beds, and the importance of hygiene. Tine Thevenin points out that the exact type of hygiene was rarely mentioned, and hypothesises that the factor of communicable diseases may have had some influence on the success psychiatrists had in convincing parents not to indulge their children. The less one touched, or was touched, the less chance there was of giving or receiving a communicable illness (Thevenin, 1987), and this was put forward by Holt (1957) as a reason for parents not to sleep with their infants (Holt 1957, Morelli et al., 1992). By this time the view that it was dangerous to sleep with babies was widespread, and further persuaded mothers to sleep babies by themselves.

During the 1940's the one child family became popular in the USA. Families were smaller and houses were built with three or four bedrooms. Individual bedrooms for each child became necessities rather than exceptions (Thevenin, 1987). The bedroom business boomed as aids to assist people to sleep became widely available. Thevenin proposes that these gadgets, ranging from sleep masks to recordings of soporific music, were 'only subtle substitutes for another's warm, soothing and relaxing companionship' (Thevenin, 1987, p. 61). The belief in Western societies such as Britain and the United States was that, in order to promote the healthy psychological development of children, it was essential to train infants from an early age to be independent and self reliant from their parents at night. This widespread cultural belief was representative of the childcare advice parents received from modern health care professionals of the time, most notably from Spock (1945):

> 'I think it's a sensible rule not to take the child into the parents' bed for any reason' (Spock, 1945, p. 101).

Spock also had advice regarding room-sharing. He discouraged room-sharing after six months of age, on the basis that the baby may become dependent on the arrangement and afraid and unwilling to sleep elsewhere. The baby may also wake and witness his parents' intercourse and be 'much disturbed' (Spock, 1969). Having stimulated fears of psychological trauma and mental illness in the concerned parent, Spock (1969) then remarks that it probably does not matter where the baby sleeps if there is no choice due to lack of space!

Norms for sleep/wake patterns in infancy, involving infants sleeping alone in cots or cribs, were developed in the 1950's and 1960's (Kleitman and Engelman, 1953; Parmelee, et al., 1964), decades which also marked the nadir of breastfeeding in the United States and much of the Western world (Elias et al., 1986). By the 1950's, articles on the big generation gap and the lack of respect that youth had for its parents appeared in many publications (Thevenin, 1987). Some publications began to suggest that it was alright for young children to spend some time in their parent's bed (Newton, 1957). The need for more information about breastfeeding resulted in the birth of the La Leche League, and articles began to appear that suggested a crying baby was an unhappy baby who needed comforting (Thevenin, 1987). Natural childbirth classes became popular and gained momentum in the 1950's, and in 1960 the International Childbirth Education Association in the USA was formed.

Until mid-1900, European and American cultures tended to consider the emotional commitments and care of babies to be a mostly female role, however this began to change with fathers taking a more active role in the care of their offspring in the 1960's. Young parents began to express dissatisfaction with childrearing practices of the previous generation. Prepared childbirth, breastfeeding and a loving, understanding approach to children gained popularity (Thevenin, 1987).

By the 1970's Ashley Montagu's book 'Touching: The Human Significance of Skin' had become a bestseller and throughout the book he promotes the practice of family co-sleeping (Montagu, 1971). In 1975, Jean Liedloff published her book 'The Continuum Concept' (Liedloff, 1975) which received great critical acclaim and has earned a substantial following in many countries. Liedloff presents an approach for caring for children without conflict based on her observations of the Yequana, Stone Age Indians in Venezuela. In this society where mutual love and respect are the basis for every dealing with others, child care practices such as family co-sleeping, unrestricted breastfeeding and babies carried almost continuously for the first six to eight months, are the norm. In 1976, Tine Thevenin published the first edition of 'The Family Bed' (Thevenin, 1987) which examined family co-sleeping as a way to solve night-time problems with young children and a means of creating a closer bond between family members.

In an approach which combined the fields of medicine and anthropology, Professor James McKenna questioned the use of the cot in 1986. It was controversial ground:

> 'For other mammal infants but especially primate infants, short-term separation leads to physiological consequences. This conclusion forces us to consider the possible effects of nocturnal separation on human infants who, in Western and urban societies, regularly sleep apart from their parents in separate rooms.' (McKenna, 1986, p. 38)

In 1989, Deborah Jackson, published the first edition of her book 'Three in a Bed: Why you should sleep with your baby' (Jackson, 1989). This carefully researched book which advocates family bed-sharing and a more baby-centred approach to family life, has remained a consistently popular childcare text. A revised and updated edition, which includes a summary of investigations conducted into bed-sharing and the association with SIDS, was published in February 1999 with the title 'Three in a Bed: the benefits of sleeping with your baby' (Jackson, 1999).

Summary

In the 1990's, bed-sharing with babies is still a practice which is far from routine in Western societies, such as Britain and the USA, where the child care philosophy of night-time parent-infant separation is unique when compared to communities around the world (Barry and Paxson, 1971; Morelli et al., 1992; Mosko et al., 1993). However, although habitual bed-sharing is not common (Hiley, 1995b), bed-sharing with babies and children does occur in the West for a variety of reasons (Mandansky and Edelbrock, 1990; Morelli et al., 1992; Heron, 1994; Hooker, 1995).

It appears that Western society is approaching the end, or rather the beginning of a full circle with regard to childcare practices. In ancient times, the whole family slept together. Babies were carried, breastfed and taken care of when in need. In the 17th and 18th centuries the child began to be noticed as someone who had to be molded. Early independence was stressed and separation from family members became fashionable. Although children occupied a central position in the family in the early to the mid-1900's, discipline and independence were promoted and the child was often separated from the family at birth and during the night. By the 1960's and 1970's many parents expressed dissatisfaction with childcare practices of the previous generation and began to discuss where children should sleep (Thevenin, 1987).

Interestingly, parallel to these changing views regarding childcare practices, is the finding that in many parts of the western world including Britain and Australasia, the tide is now turning against the protech school of thought with regard to birth (Young, 1995). In Britain, an inquiry by the House of Commons Health Committee focused on what women wanted from maternity services (Lawson, 1992). The findings culminated in the Department of Health report 'Changing Childbirth', a maternity manifesto published in 1993 which recommended that a woman's choice is paramount; maternity services to be drawn away from hospitals into the community; and midwives given the leading role, while obstetricians would deal mostly with cases where complications arose (Department of Health, 1993). These proposals aimed to demedicalise normal childbirth, as doctors would only be involved where clinically appropriate.

Today, several accounts acknowledge the value placed on bed-sharing by some families (Brazelton, 1990; McKenna, 1996a), or advocate the practice (Thevenin, 1987; Jackson, 1999). Although some paediatricians still advise parents to avoid bed-sharing (Lozoff et al., 1984; Mitchell, 1996), recommendations put forward by medical and midwifery professionals regarding this childcare practice, and the conditions under which it occurs, are currently the subject of discussion and review (Kattwinkel et al., 1997; Ashmore, 1997; Young et al., 1998; Blair et al., in press).

Chapter 3

Bed-sharing and Room-sharing: A Literature Review

The Literature Search

Research reports and review papers which discussed night-time infant care practices, maternal-infant behaviour and interactions, and Sudden Infant Death Syndrome were identified using CINAHL, MEDLINE, PsycLIT and BIDS Social Sciences Citation Index databases which searched the literature published from 1982 to October 1998 (CINAHL); 1966 to January 1999 (MEDLINE); 1887 to December 1998 (PsycLIT) and 1981 to February 1999 (BIDS). Key words used in the searches include 'bed-sharing', 'co-sleeping', 'family bed', 'room-sharing', 'sudden infant death syndrome', 'infant sleep', 'mother/maternal-baby/infant interactions', 'parent-infant' interactions', 'infant care' and 'infant care practices'. Reference lists were also obtained through the author's attendance at conferences and research meetings in which infant care practices, mother-infant interactions, and SIDS were topics of discussion. Personal communication with fellow researchers interested in night-time infant care practices yielded further references, including papers currently in press. Assistance is acknowledged from Professor James McKenna, Department of Anthropology, University of Notre Dame, Indiana, USA; Paul Heron, Psychology Graduate of the University of Bristol; Deborah Jackson, author of 'Three in a Bed', and Dr Helen Ball and Elaine Hooker, Department of Anthropology, University of Durham. Several research reports that were found to recur on reference lists of papers obtained through the computer searches were traced to their primary sources and added to this literature review.

Relevant research reports and article reviews obtained in this literature search which comprised medical, midwifery, nursing, anthropological, psychological and pyschiatric sources have been grouped into broad categories which address infant care practices, maternal-infant behaviour and physiology, and the association with SIDS. The categories which will be the focus of this literature review address parent-infant bed-sharing and room-sharing together with other night-time infant care practices, and will include anthropological studies and the evolutionary history of infant sleep and care practices; physiological effects of mother-infant interaction; cross-cultural studies of infant care practices and SIDS; epidemiological studies investigating risk factors for SIDS; the known physiological effects of room-sharing, bed-sharing and co-sleeping practices; the association of bed-sharing with childhood sleep problems; the effects of co-sleeping on later life development; and the relationship between breastfeeding and bed-sharing.

Definitions of Co-sleeping, Bed-sharing and Room-sharing

Review of the available literature revealed diversity in the terminology and definitions which have been used in research investigating infant and child sleep location. There is no consistent definition of 'co-sleeping' in the literature (Schachter et al., 1989; Rath and Okum, 1995) which makes discussion of the topic, especially as a risk factor for SIDS, more difficult. Studies attempting to examine the practice of 'co-sleeping' have often failed to distinguish room-sharing from bed-sharing; occasional from habitual co-sleeping or bed-sharing (Oleinick et al., 1966; Madansky and Edelbrock 1990); and between frequent all-night co-sleeping and frequent part-night or occasional co-sleeping. The term 'co-sleeping' has included situations in which 1) the parent(s) and the infant share the same bed; 2) the parent(s) and the infant sleep in close proximity without bodily contact; and 3) the infant sleeps in the arms of, or in a sling on, an awake parent (Mitchell and Thompson, 1995; McKenna, 1996). Many researchers (Lozoff et al., 1984; Schachter et al., 1989; Forbes et al., 1992; Morelli et al., 1992; Mitchell and Thompson, 1995; Rapisardi et al., 1995; Rath and Okum, 1995; Hayes et al., 1996) have accepted a definition of 'co-sleeping', similar to that proposed by Medoff and Schaefer (1993):

> 'Co-sleeping is the practice of sharing a bed with another person'(Medoff and Schaefer, 1993, p. 1)

However for many studies the term 'co-sleeping' was defined by the frequency with which this practice occurred. Simonds and Parraga (1982) defined it as the child's insistence on sleeping with family members at frequencies ranging from once or more per week to at least once in six months. In other studies (Lozoff et al., 1984; Schachter et al., 1989) co-sleeping referred to sleeping in the same bed more than once per month for more than one hour per day. Others have inquired about the child's history of coming into the bed when ill or frightened (Rosenfeld et al., 1982) and the frequency of sleeping in the parent's bedroom (Ragins and Schachter, 1971).

The majority of these investigations into co-sleeping have been based in the United States where it is common for infants to sleep in a separate room from their parents (Morelli et al., 1992), which is often referred to as 'solitary sleeping' (McKenna et al., 1993). This may be an explanation for why co-sleeping has become synonymous with bed-sharing (Kattwinkel et al., 1997). Room-sharing with infants is a relatively common practice, at least in the United Kingdom and Australasia (Blair et al., in press, Byard 1994, Fleming et al., 1996, Mitchell et al., 1997) and has been advocated as a way to reduce the risk of SIDS (Mitchell and Thompson, 1995). It is therefore important to differentiate between the practices of bed-sharing and room-sharing, as according to a widely accepted definition proposed by McKenna and colleagues, both may be considered to be co-sleeping environments:

> 'Co-sleeping may be defined as sleeping either in contact with another person (in someone's arms, passively touching while lying in bed) or close enough to access, respond to or exchange sensory stimuli such as sound, movement, touch, vision, gas and olfactory stimuli.'(McKenna et al., 1993, p. 264).

This definition of 'co-sleeping', which considers the infant's viewpoint, will be used for the purpose of this thesis, and includes both bed-sharing and room-sharing practices. Bed-sharing has been defined for the purpose of this investigation and review as an infant sleeping in the same bed as the parent(s), and room-sharing as an infant sleeping on a separate sleeping surface in the same room as the parent(s).

<u>The Evolution of Infant Sleep</u>

Solitary sleeping in infancy, whereby an infant is expected to sleep alone, usually in a cot or crib and often through the night, has been practiced by humans for only about 200 years (Mosko et al., 1993; Trevathan and McKenna, 1994). Only in Western industrialised societies where the establishment of early independence is the developmental goal and autonomy the desired outcome, such infant care practices are encouraged and conceptualised as a normal and desirable sleeping arrangement (Morelli et al., 1992; McKenna et al., 1994). Solitary sleeping represents a biologically and historically novel sleep environment, the consequences of which, both short and long term, have only recently begun to be considered and explored (McKenna et al., 1993; 1997; Mosko et al., 1993; Richard et al., 1996; Young et al., 1997; 1998).

Childcare practices in relationship to SIDS prevention have proven extremely important in the past decade (Guntheroth and Spiers, 1992; McKenna, 1996a). From an anthropological perspective however this is not surprising. A prolonged developmental period of physical dependence on a primary caregiver characterises the evolutionary history of the human infant (Lozoff and Brittenham, 1979; McKenna, 1990; Trevathan and McKenna, 1994). Anthropological studies have demonstrated that continuous contact and carrying, including the co-evolution of parent-infant co-sleeping with breastfeeding as one integrated care system, have characterised the human infant's developmental experiences for well over 5 million years (Whiting, 1963; McKenna, 1995a).

Co-sleeping is therefore the context in which the neurological and physiological systems which control infant sleep evolved and is, according to Bowlby, 'the environment of evolutionary adaptedness' (Bowlby, 1969 cited by McKenna et al., 1993, p. 264). Evidence from the fields of anthropology, medicine, physiology and psychology indicate that the social care of infants is practically synonymous with physiological regulation (Korner and Thoman 1972; Montagu, 1978; Reite and Field, 1985; Trevathan and McKenna, 1994). At birth, the human brain is only 25% of its adult weight, making the human infant the least neurologically mature primate of all, and subject to the most extensive regulation and support for the longest period. A proposition put forward is that for infants to survive, and for human reproductive success to be maximised, natural selection was likely to favour the co-evolution of highly motivated caregivers together with highly responsive infants; infants designed to respond to and depend on external parental sensory signals and regulatory stimuli in a microenvironment in which mothers and infants are almost always in contact (McKenna, 1986; Mosko et al., 1993). Chimpanzees and gorillas, the closest living primate relatives to humans, co-sleep for the first few years of life, and remain in almost continual direct physical contact with a caregiver both day and night throughout this period. Humans however, are born more immature than other primates as a result of concomitant brain enlargement and reduction in the size of the pelvic opening caused by bipedalism. In contrast to other primate infants, human babies cannot cling to their parents or ambulate, causing them to be even more dependent on the caretaker to provide for their basic needs (Trevathan, 1987; McKenna et al., 1993). Anthropological and archaeological evidence suggests that our human ancestors fulfilled these infant needs by carrying the baby, possibly in a sling, during the day and by co-sleeping at night, as is still done in present day hunter-gatherer societies and nonindustrialised cultures (Barry and Paxson, 1971; Lozoff and Brittenham, 1979; Konner and Worthman, 1980). Through sustained physical contact with a caregiver, human infant vulnerabilities were offset and the chances of infant survival were maximised (McKenna et al., 1993).

The composition of human milk also supports this pattern of close and continuous mother-infant contact, including co-sleeping, as suggested by archeological records. Compared with milk of other mammals, human milk is low in fat and protein and relatively high in carbohydrates, especially lactose; a key nutrient for brain growth. Interestingly the concentration of lactose in milk is highest among primates whose infants are the least neurologically developed at birth. In mammalian species with intermittent maternal contact, infants are adapted for separation by receiving their total nutritional requirements in feedings during the mother's visits, spaced from 2 to 15 hours apart. In these 'cache species', milk is high in fat and protein, allowing the young to be satiated for longer periods of time (Lozoff and Brittenham, 1979). The composition of human milk, which provides fewer calories per feeding, suggests that the infant is adapted to a pattern of care which involves frequent feeding and extensive maternal contact, which comparative physiology studies have identified as that of a 'carrying' species (Lozoff and Brittenham, 1979; McKenna et al., 1993).

The McKenna Theory

From an evolutionary and developmental perspective, McKenna and Mosko (1993) put forward the view that parental contact and proximity with infants, while awake and asleep, represents a developmental bridge for the infant which extends the role the mother played prenatally in regulating important aspects of her infant's continuing development, into the postnatal environment. McKenna, Mosko and colleagues have also proposed that co-sleeping parents may assert potentially protective, physiological regulatory effects on their infants (McKenna 1986; McKenna et al., 1990; 1993; Mosko et al., 1993; 1997a; 1997b). Their evolutionary perspective suggests that intense and prolonged mother-infant contact, both day and night, evolved specifically to buffer infants from various kinds of environmental assaults, infantile vulnerabilities, or physiological deficiencies, including SIDS (McKenna, 1996a). McKenna argues that one of the suspected deficits involved in some SIDS deaths is the apparent inability of the infant to arouse to reinitiate breathing during a prolonged breathing pause. Specifically because it induces infant arousals and offers regulatory effects on infant physiology, the sensory communication involving tactile, vestibular, auditory, thermal, olfactory and CO_2 sensory exchanges that continuously occur between co-sleeping pairs should help to reduce the number of what some researchers have called 'adaptive failures', by stimulation of a vulnerable subgroup of infants with a sleep induced arousal deficit (McKenna, 1986; Mosko et al., 1993). McKenna and colleagues question whether an infant's biology can change as quickly as cultural child care patterns. Parental sensory cues were reliably present throughout the evolution of infant sleep physiology, and infants sleeping in solitary isolation from their parents is a relatively recent phenomenon. A solitary sleeping infant therefore faces a set of environmental or experiential circumstances extraordinarily different from a co-sleeping infant which may not be in his/her biological best interest.

The Hunter-Gatherers

Hunter-gatherer societies such as the !Kung peoples of Botswana and Namibia, play a key role in anthropological theory. They are believed to represent some aspects of the subsistence ecology, demography, and social organisation of Pleistocene human groups. These as well as other features of their society, culture and health have been extensively described, including the care and development of infants (Lozoff and Brittenham, 1979; Konner and Worthman, 1980). Infants are always in immediate physical proximity with their mothers until age 2 or older, and separations are brief until they are about 3½ years, when they are weaned during a new sibling's gestation. Mother-infant bed-sharing on skin mats with nocturnal breastfeeding is customary until the infant is weaned (Konner and Worthman, 1980).

Maternal Physiological Regulatory Effects on Infants

Recent laboratory studies corroborate the importance of maternal contact and are consistent with the perspective put forward by McKenna, Mosko and colleagues (McKenna et al., 1993, Mosko et al., 1993). Many studies reveal that among mammals, and particularly for primates, all of whom are born neurologically quite immature and develop slowly, parent contact asserts measurable physiological consequences. Researchers (Reite et al., 1982) have argued that the social-psychological consequences of separation from a caregiver cannot be analysed thoroughly without also considering the underlying physiological adjustments an infant must make when sensory interaction between them is terminated suddenly. Separation causes changes in the fundamental efficiency of the systems which were not previously thought to be regulated by the presence or absence of a caregiver (McKenna et al., 1993).

Laboratory studies of several monkey species have demonstrated that when separated from their mothers, even infants as old as four to six months of age lose body temperature (Reite et al., 1978a; 1978b) and can experience disturbances in sleep, with decreased Rapid Eye Movement (REM) sleep periods (Reite and Short, 1978; Hofer, 1983); changes in electroencephalogram (EEG) activity (Short et al., 1977; Reite et al., 1982); alterations in cellular immune response which compromise the immune system (Reite et al., 1981; Coe et al., 1985), and cardiac arrhythmias (Seiler et al., 1979). Using a primate model, separation has also been shown to increase adrenal secretions and plasma cortisol levels, indicative of a stress response (Coe and Levine, 1981); decrease the ability to combat pathogens because of a reduction in immunoglobulins (after seven days) (Reite et al., 1981); and reduce the levels of antibodies against certain bacteria strains (Coe et al., 1985).

Among mammals such as rat pups, it has been established that maternal contact regulates the production of enzymes needed to release growth hormone. Separation from their mothers causes these infants to experience a drop in growth hormone levels concomitant with a corresponding drop in a brain enzyme (ornithine decarboxylase, ODC) needed for the synthesis of several brain proteins (Kuhn et al., 1978). The drop in these two substances was not related to nutritional or body temperature changes associated with separation, but appeared to be related to some unknown aspect of the pup's interaction with its mother. The mother's presence was important in the infant's release and production of the growth hormone. Studies by Johnson and colleagues (1996) also suggest that the quality of parental care influences later growth and development in primate species. Reite and Capitanio (1985) propose that such findings may help to explain the 'failure to thrive' syndrome defined by Powell et al. (1967), in regard to human infants deprived of physical affection. Despite a diet sufficient to sustain life, these infants lose weight and many die, which implies that physical stimulation is essential to ensure normal weight gain and survival in addition to adequate food intake (McKenna et al., 1993).

Only a few studies have examined the immediate physiological effects of human parent-infant separation. In a study examining neonatal sleep/wake patterns at night, Keefe (1987) found that 'rooming in' newborns spent more time in quiet sleep than infants sleeping away from their mothers in the hospital nursery. Another study by Fardig (1980) found that for seventeen mothers and babies, newborns placed in incubators lost up to 1.5°C of body temperature compared with newborns placed directly, skin-to-skin, onto their mother's chest immediately after birth, despite equivalent ambient temperatures. The author suggested that production of stress hormones, such as cortisol, produced when the infant was separated from his mother, may cause a drop in body temperature.

Many studies have shown the beneficial physiological effects of mothers holding their preterm and newborn babies using skin-to-skin contact or the kangaroo method of baby care. Documented benefits include an increase in infant skin temperature, stabilised heart rates, improved oxygenation, and a reduced frequency of apnoeas and crying episodes (Whitelaw et al., 1988, Acolet et al., 1989; Ludington-Hoe, 1990; Anderson, 1991; Ludington-Hoe et al., 1991; Christensson et al., 1995). Infants who received kangaroo care maintained their own body temperature sooner; achieved earlier discharge from hospital; and cried less at 6 months, compared to controls (Whitelaw et al., 1988; Anderson, 1991). Skin-to-skin contact has also been associated with an increased incidence of breastfeeding, longer breastfeeding duration and enhanced milk production (Whitelaw et al., 1988; Anderson, 1991).

A study by Christensson et al. (1995) suggested that the human newborn cry is not dependent on earlier social experience and may be a genetically encoded reaction to separation; human infants recognise physical separation from their mothers and start to cry in pulses. The observed postnatal cry may be a human counterpart to the 'separation distress call' which is a general phenomenon among several mammalian species, and serves to restore proximity to the mother. These findings are compatible with the opinion that the most appropriate position of the healthy full-term newborn baby after birth is in close body contact with the mother (Christensson et al., 1995).

The data presented is evidence supporting the impact mothers have on regulating their infants' physiology and the often deleterious consequences of mother-infant separation. In Western societies where babies are often separated from their parents for the nocturnal sleep, which McKenna regards as an evolutionary novel situation (McKenna, 1986), there is no reason to believe that infant physiology and behaviour are not also affected.

Cross-Cultural Studies of Bed-sharing Practices

Prevailing cultural beliefs regarding desirability and safety largely determine whether infants share the parental bed. Consequently there is widespread cultural diversity in where infants are routinely placed to sleep. One of the most valuable aspects of comparisons across different cultures is that they make us aware of the cultural basis for, and the assumptions underlying, our own practices, whoever we are (Whiting and Edwards, 1988; Morelli et al., 1992).

In Western industrialised societies, the ability to condition infants and children to sleep alone throughout the night as early in life as possible, is a developmental goal around which both infant-child maturation and parenting skills are evaluated and rated (Morelli et al., 1992), and is considered by many to be essential for the infant's healthy psychological development (Mosko et al., 1997a). These societies have largely adopted the practice of solitary, separate room sleeping for infants (Morelli et al., 1992; Mosko et al., 1997a). Although several accounts now acknowledge the value placed on bed-sharing by some families (Brazelton, 1990; McKenna, 1996a), or advocate the practice (Thevenin, 1987; Jackson, 1989; 1999; Sears and Sears, 1993), paediatricians generally advise parents to avoid bed-sharing (Lozoff et al., 1984). For the majority of the world's cultures however, some form of co-sleeping is still the customary arrangement for the first few years of a child's life.

J.W.M. Whiting (1964) reported that infants sleep in bed with their mothers in approximately two thirds of the 136 societies he sampled around the world, and in the remainder of these societies the babies were generally sharing the same room as their mothers to sleep. Thus the fraction is much higher if the definition of co-sleeping is extended to include room-sharing. Additional reports from this study suggested that the American middle class was 'unique in putting their baby to sleep in a room of his own' (Burton and Whiting, 1961, p. 86).

A survey conducted by Barry and Paxson (1971) of infant and early childhood cultural practices in 186 societies, representative of all the major known cultural types in the world, obtained reliable data on infant sleeping arrangements in 130 societies. Night-time sleeping proximity of mother and father to infant was coded. In *all* of the societies in which reliable data was available infants shared the same room with at least one parent, usually the mother, and in 44% of cultures this involved sharing the same bed or sleeping surface with one or both parents. Of the remaining cultures studied, 35% were coded as mother and father sleeping in the same room as the infant, however the bed was not specified (i.e. not coded as the 'same' or 'different' to the infant). It is therefore possible that many more of the cultures (more than 44%) included in the survey practise parent-infant bed-sharing, than indicated by the initial findings.

Asian communities

For the purpose of this review, families of Asian ethnic origin have been grouped into two broad categories to avoid confusion with the terminology used in different cross-cultural studies: i) East Asian ethnic groups include families of Chinese, Cantonese-Chinese, Japanese, Taiwanese, Vietnamese, Korean, Philippino and Malaysian origin. Some studies have defined these groups as being of Oriental ethnic origin. e.g. Kyle et al. 1990; whereas in the USA (Grether et al., 1990) and Australia (Kilkenny and Lumley, 1994) these ethnic groups are usually defined as 'Asian'. ii) West Asian ethnic groups include families of Indian, Pakistani and Bangladeshi origin, i.e. people originating from the Indian sub-continent. Some studies have included these West Asian ethnic groups under the broad heading of 'Asian' also (Farooqi, 1994). Where the term 'Asian' is used, it represents both East and West Asian ethnic groups, unless otherwise defined by the study under review.

Communities that practice bed-sharing include both highly technological and less technological societies. Japanese children in urban settings usually sleep adjacent to their mothers in early childhood and generally continue to sleep with a parent or an extended family member in the same room, until the age of 10 to 15 (Caudill and Plath, 1966). Japanese parents believe their infants are born as separate beings who must develop interdependent relationships with community members to survive; bed-sharing and/or room-sharing with infants and young children is thought to facilitate this process (Caudill and Plath, 1966). The mother-infant relationship is considered by the Japanese as consisting of only one individual; mother and baby are not divided (Caudill and Weinstein, 1969; Kawakami, 1987 cited by Morelli et al., 1992). It is therefore not surprising that some reports have noted that

> 'the Japanese think the US culture rather merciless in pushing small children toward such independence at night' (Brazelton, 1990, p. 7).

Japanese parents often separate in order to provide all children with a parental sleeping partner when family size makes it difficult for parents and children to share a single room, as

> 'to sleep alone is considered somewhat pitiful because a person would, therefore, be lonely' (Caudill and Weinstein, 1969, p. 15).

Space considerations appear to play a minor role in co-sleeping practices for Japanese families, with about 85% of young children sharing the parental bedroom (Caudill and Plath, 1966). In Japan, where mother-infant bed-sharing on futons remains the norm (Takeda, 1987) current published SIDS rates remain the lowest in the world; the most recent national estimate is 0.3/1000 live births (Watanabe et al., 1994; McKenna, 1996a). However McKenna (1998) has recently reported that the SIDS rate in Japan has increased over the last few years, and has been paralleled by a shift from a tradition of social sleeping to solitary sleeping.

Epidemiological observations within co-sleeping Asian communities, inclusive of eastern and western Asia, consistently report low rates of SIDS even when crowded housing and poorer socioeconomic conditions would predict a relatively higher incidence of the syndrome (Davies, 1985; Balarajan et al., 1989; Lee et al., 1989; Gantley et al., 1993; Farooqi et al., 1994; Nelson and Chan, 1996). In these communities, babies experience very different childcare practices and sensory environments when compared to white, Western babies. They are more likely to sleep in, or close to, their parents' bed at night, and during the day the extended family network provides an almost constant source of contact with adults and other family members. Asian households are generally busier and babies are always being picked up; a home environment which is very different from the typical nuclear unit of mother-father-child or mother-child unit seen in Western cultures such as Great Britain and the USA. Asian babies are openly admitted by their mothers to be vulnerable and by implication need protecting. Early independence, often sought in Western societies, is not an issue (Gantley et al., 1993; Davies, 1994).

In 1985, Davies reported on the rarity of SIDS in Hong Kong (Davies, 1985). He speculated that the rate of SIDS reported at 0.036/1000 live births, approximately 50 to 70 times less common than in Western societies, may somehow be a result of influences of lifestyle and caretaking practices, including crowded living conditions, and placing infants supine to sleep (Davies ,1985). A follow-up study on Davies' work by Lee and colleagues (1989) confirmed the low incidence of SIDS in Hong Kong. A higher incidence was found than originally reported, 0.3/1000 live births, which was attributed to differences in diagnostic criteria at necropsy. This incidence was however still much lower than reported SIDS rates in Western countries (approximately 2-4/1000 live births) at the time (Lee et al., 1989). These researchers called for more attention to be paid to child care practices in the understanding of the aetiology of SIDS.

Low SIDS rates continue in Asian ethnic groups even after they immigrate to Western (non co-sleeping) cultures, where most continue their traditional care-giving practices, which include bed-sharing and co-sleeping (Balarajan et al., 1989; Gantley et al., 1993). Balarajan et al. (1989) reported the low incidence of SIDS in infants of Asian origin living in England and Wales, despite comparatively high mortality from other causes. Ethnic group in this study was determined by the mother's country of birth, with mothers born in Pakistan, India and Bangladesh being included in 'Asian' ethnic groups. As the authors identified, Asian women have fewer illegitimate births, fewer births at a younger age, and few of them smoke, variables all associated with a lower risk of SIDS. Sleeping patterns were not mentioned as an explanation for the lower incidence, however it is likely that these infants were sleeping with or near their parents (Nelson and Chan, 1996). These findings have been confirmed by Kyle and colleagues (1990) in Birmingham, Hilder (1994) in London, and Bacon (1994) in Yorkshire. Although postneonatal mortality was higher amongst Asians (i.e. people originating from the Indian subcontinent), the incidence of SIDS was less than half the rate of white infants, despite poor socioeconomic conditions.

Gantley, Davies and Murcott (1993) reported broad cultural contrasts between Bangladeshi and Welsh mothers' beliefs and infant care practices in their investigation into possible factors contributing to the low incidence of SIDS in Asian populations. Their sample (n=60) included mothers of working and middle class occupational status, with an infant under one year of age. Bangladeshi babies were considered vulnerable and slept close to other people both day and night; at night they were either in the mother's bed or in a cot next to it, a practice also reported by Farooqi and colleagues (1991). Older infants were also likely to sleep in their parents' bedroom. In contrast, babies born of Welsh and English parents were sometimes placed in cots in their parents' rooms for two to three months, and then encouraged (close to the peak age for SIDS) to sleep alone; where possible in their own room (Gantley et al., 1993). Bangladeshi babies were not expected to sleep through the night, and there was more emphasis placed on the length of night-time infant sleeping time by Welsh parents. The authors concluded that long periods of lone, quiet sleep may be one factor which contributes to a higher rate of SIDS in white compared to Asian infants. Farooqi and colleagues confirmed the practice of bed-sharing and co-sleeping in Asian communities. Their survey of 374 mothers conducted in west Birmingham indicated that 94% of Asian infants slept in their parents' bedroom in the first year of life compared with 61% of whites, and three times as many Asian infants shared the parental bed (36% versus 11%). This study also showed that smoking was a rarity among Asian mothers (Farooqi et al., 1993; Farooqi, 1994; Farooqi et al., 1994).

Nelson and Chan (1996) recently published a study of child care practices and cot death in Hong Kong. Of the 195 mothers recruited, 100 completed the two part study which involved postnatal interviews and postal questionnaires. 81% of babies slept in their parents' room. Of this group 32% (32/99) bed-shared, but only a third of these babies were described as sleeping in direct contact with a parent. Maternal smoking was uncommon. The investigation also found that babies in Hong Kong appear to sleep on firmer surfaces when compared with a sample of babies from southern New Zealand. The authors point out that the term 'bed-sharing' has different connotations for different people. For example a baby sleeping at arms length from the mother on a firm surface, as is often the case in Hong Kong, is in a very different situation to a baby sleeping in direct skin-to-skin contact with the mother on a soft mattress and covered by a thick duvet (Nelson and Chan, 1996).

In a comparison of SIDS rates and cultural practices, Scragg (1996) proposes an explanation for the observation that Hong Kong infants have a low SIDS rate despite a high occurrence of bed-sharing. In New Zealand, the combination of maternal smoking and bed-sharing greatly increased the SIDS risk several fold, whereas the data from Nelson and Chan (1996) shows that this double exposure is rare in Hong Kong (between 0 and 3%). By contrast, bed-sharing infants of non-smoking mothers have little or no increase in the risk of SIDS (Scragg, 1996). The interaction between bed-sharing and maternal smoking which results in an increase in the risk of SIDS is discussed later in this chapter.

Mosenkis (1998) cites an unpublished paper by Juang (1996) on the attitudes and cultural values surrounding the practice of co-sleeping in Taiwan. While all of Juang's participants (n=30) approved of co-sleeping, there was a wide range of ages at which co-sleeping was judged as acceptable. Independence was the common response when asked why a child should eventually stop sleeping with parents, as is typical for Americans (Morelli et al., 1992). With the maximum age for co-sleeping ranging from 16 months to 12 years old however, the Taiwanese clearly have different views than Americans usually have on the age at which this particular part of independence must develop. Taiwanese parents who gave the lowest maximum age for co-sleeping tended to have had exposure to Western culture through having studied or lived in the United States. Juang (1996 cited by Mosenkis, 1998, p. 10) makes the argument that co-sleeping is an example of the cultural struggle that Taiwan is facing, with the traditional (co-sleeping) in opposition to the Western (solitary sleeping) values. For Juang, co-sleeping is deeply tied to issues of culture; a shift in sleeping arrangements represents a shift in cultural values (Mosenkis, 1998).

An interesting, however tragic finding, is that among East Asian populations in the United States (in this case referring to Chinese, Japanese, Vietnamese, or Philippino, defined by the mother's own report), the incidence of SIDS increased with period of residence (Grether et al., 1990). Similar findings are reported by Kilkenny and Lumley (1994) for Asians living in Australia. Perhaps the trend toward higher SIDS rates reflects the adoption of more 'Western' patterns of infant sleep management i.e. prone positioning and solitary sleep, among others. This proposition is supported by the observation that use of the prone position was higher among West Asian mothers born in the United Kingdom and those who had lived in this country for longer periods of time, prior to the 'Back to Sleep' campaign (Farooqi, 1994). Farooqi (1994) suggests that a better understanding of English, education and media have played an influential role in modifying the behaviour of these women, inadvertently placing the infants of British-born Asian mothers at greater risk of SIDS than if their mothers had persisted with the traditional supine position (Farooqi, 1994). The adoption of Western ways, including maternal smoking, may also be part of the causal chain for the few SIDS deaths which have begun appearing among the Pacific Islanders in New Zealand. The numbers are small, but Pacific Island health workers suggest that SIDS deaths are new to this population (Gantley, 1994).

Ethnic communities

In addition to the information available relating to SIDS and childcare practices in Asian societies, a study of ethnic communities living in Australia has reported a very low incidence of SIDS in communities where mothers were born in Southern Europe; mostly Italy, Greece and former Yugoslavia, as well as Asian born mothers. These substantial ethnic differences were not explained by social and perinatal risk factors, however maternal smoking was lower in these groups compared to Australian-born mothers (Kilkenny and Lumley, 1994). These researchers also call for an examination of child care practices in the understanding of contributing factors to SIDS.

Although ethnic origin often has a strong effect in reducing the incidence of SIDS, some ethnic communities report higher rates of SIDS than the white population in the same country. In New Zealand, Maoris have a rate approximately 7.4/1000 (Scragg et al., 1993), and while in the USA and Britain, the incidence of SIDS is low in Asians (0.5/1000 and 1.2/1000 respectively) it is much higher in the black population in both countries (5.0/1000 and 5.2/1000 respectively) (Balarajan et al., 1989; Hoffman and Hillman, 1992; Wolf and Ikeogu, 1996). Irwin and colleagues (1992) also found that Native American Indian infants were more than three times more likely to die from SIDS in Washington state. The high incidence among Native American Indians in the USA has been previously reported (Kaplan et al., 1984, Oyen et al., 1990). The authors attribute this high rate of SIDS to the increased prevalence of SIDS risk factors among Native American Indian mothers including young maternal age, high parity, single marriage status and maternal smoking (Irwin et al., 1992).

McKenna (1996a) proposes an explanation for the apparent increase in SIDS rates in the black African-American population in the United States, in which bed-sharing is common, which may be extended to include Native American Indians, and the Maori population in New Zealand. The potential benefits of co-sleeping may be overridden by the fact that black mothers (and Maoris and Native Americans) have their infants at a younger age (<20 years), smoke during their pregnancies, live in impoverished conditions, are less likely to be married, lack access to education on both parenting and prenatal care, and do not breastfeed (Mitchell et al., 1992; Hoffman and Hillman, 1992). All of these factors are known to increase the risk of an infant dying from SIDS (Mitchell et al., 1992; Hoffman and Hillman, 1992; Blair et al., 1996; Fleming et al., 1996).

However not all predominantly black communities report high SIDS rates. A prospective study conducted in Zimbabwe by Wolf and Ikeogu (1996) report a SIDS incidence of only 0.2/1000 live births in their black African population, despite poor socioeconomic circumstances, high unemployment, and high density living with overcrowded accommodation. The authors suggest that childcare practices, parental lifestyle and the home environment in this community, in which the extended family is commonplace and infants are not isolated from events in the rest of the household, is very different from that of Europe and may explain the low incidence of SIDS. This study also reported that

African mothers invariably breastfeed for several months, and that smoking, drug and alcohol abuse are virtually unknown among this group of mothers. Although not mentioned in this report, it is highly likely that infants share the parents' room to sleep, if not bed-share on the same sleeping surface.

Surveys of bed-sharing and room-sharing practices in the USA

Studies of infant care practices in the USA in the 1970's and 1980's indicated that sharing the parental bed was not a common practice in middle to upper-class American families. A study by Hong and Townes (1976) investigated feeding practices, sleeping arrangements and childrearing practices in a group of 279 children aged 7 months to 8 years from three different cultures: the USA, United Kingdom and Korea. Over half of the infants studied by Hong and Townes (1976) slept in their own rooms by 2 months of age, 75% by 3 months, and 96% by 6 months. A greater number of Korean infants slept with their mothers in the same room. Results from this study also suggest that the incidence of an infant's attachment to an inanimate object is lower in a culture or social group in which infants receive a greater amount of physical contact (Hong and Townes, 1976). Other researchers have also reported that by 6 months, most middle class U.S. infants have a designated sleeping place in a room separate from their parents (Whiting and Edwards, 1988). However the actual prevalence of co-sleeping in the USA, inclusive of bed-sharing and room-sharing, is unknown because no strictly population based survey has ever been conducted in the United States (Madansky and Edelbrock, 1990; McKenna, 1996a). There is also frequent reference to parents' reluctance to report bed-sharing because of the common belief that it is outside the norm (Kaplan and Poznanski, 1974; Hanks and Rebelsky, 1977; Rath and Okum, 1995), which may explain why archival reviews conducted by some researchers yield the lowest prevalence rates.

Hanks and Rebelsky (1977) were the first researchers to categorise co-sleeping in terms of its frequency, but it was a simple dichotomy between frequent and infrequent bed-sharing and failed to consider its duration (part or all of the night). Results of the study indicated that of the 27 participating parents with a total of 53 children aged 2 months to 13 years, 23 parents occasionally co-slept with their children. The duration of bed-sharing ranged from one child who bed-shared 'all night, every night', to others who bed-shared for two hours once or twice per month. Eighteen children (34%) were found to be frequent bed-sharers. Many parents (70%) perceived bed-sharing as related to care and nurturance of raising children, similar to previous cross-cultural studies, and most had not discussed bed-sharing with their paediatrician. The authors indicate this as a possible indicator of the prevailing cultural taboo on bed-sharing. The majority of these parents who bed-shared with their children, remembered bed-sharing with their own parents; while of the four parents who never bed-shared, none had bed-shared with their parents as children. The authors state that these data clearly support the concept that families repeat the sleeping patterns of their families of origin (Hanks and Rebelsky, 1977).

One of the most comprehensive studies of the prevalence of children sharing the parental bed has been conducted by Lozoff and colleagues (Lozoff et al., 1984; Lozoff et al., 1985; Askew et al., 1988; Lozoff et al., 1996). With the aid of well developed interview measures, and a large representative and random sample (n=150), the authors were able to draw conclusions that could be generalised to much of the US population. Lozoff and her colleagues (1984) also provided the most precise definition of bed-sharing in the literature, although in their studies they have used the term ‘co-sleeping’. The definition included four categories; occasional and frequent, part or all night bed-sharing, with the critical component that bed-sharing was recent, not exceptional and includes sleeping on the part of both parent and child (Lozoff et al., 1984). Results of the study found that sharing the parental bed with a child less than 4 years of age was ‘routine and recent’ in 35% of white families and 70% of black families. Crowell and colleagues (1987) reported even lower figures than Lozoff et al. (1984) for parent-infant bed-sharing in their sample of Caucasian 18 to 36 month olds. In this sample of 100 toddlers, 11% of children shared the parental bed for at least part of the night, three or more nights per week, with three of these families being advocates of the ‘family bed’. 15% of children shared a room with their parents three or more nights per week (Crowell et al., 1987).

A study by Morelli and colleagues (1992) examined and contrasted cultural assumptions underlying infant sleeping arrangements between middle-class US parents and Highland Mayan parents. All 14 Mayan children slept in their mother’s bed into toddlerhood. None of the 18 U.S. infants slept in bed with their mothers on a regular basis as newborns, although the majority (15 families) chose to room-share. By 6 months of age, 80% of infants had been moved to a separate room to sleep. One U.S. family moved the baby from a separate room, to their room, and then into the parental bed when the child was 12 months old. The Mayan parents explained their practices in terms of the value of closeness with infants, while their responses regarding the practice of having infants and toddlers sleep in separate rooms gave the impression that they viewed this as 'tantamount to child neglect' (Morelli et al .,1992, p. 608). Mayan mothers also reported generally not noticing being disturbed by nocturnal breastfeeding of their infants. Mothers said they did not have to waken, just to turn and make the breast accessible. The U.S. parents explained their practices in terms of the value of independence for infants. All but one of the 18 U.S. mothers reported having to stay awake during night feedings. The one mother whose infant regularly remained in bed with her following feeds was the only mother who said that nightly feeds did not bother her. The U.S. families, but not the Mayan families, used bedtime routines and objects to facilitate the transition to sleep (Morelli et al., 1992).

A recent study by Hayes, Roberts and Stowe (1996) investigated parent-child interactions during sleep onset and night-time arousals in a rural sample of sixty preschool children, aged 3 to 5 years. The role of sharing the parental bed in relation to sleep habits and night waking was examined using parental self report of both current and retrospective sleep patterns. Children were defined as co-sleepers (bed-sharers) if they currently slept with their parents 'sometimes', 'often', or 'always'. Solitary sleepers were defined as children whose parents answered 'rarely' or 'never' to this question. The results showed that solitary sleepers engaged in more complex bedtime routines, and had more longstanding and stronger attachment to security objects and sleep aids, than did co-sleepers. This finding that bed-sharers were less likely to use transitional security objects at bedtime is consistent with other studies investigating night-time behaviours of young children (Morelli et al., 1992). Infancy precursors to bed-sharing in early childhood in this study included a history of breastfeeding, night feedings in the parent's bed and returning to sleep in the parent's bed (Hayes et al., 1996).

Within the United States, demographic, ethnic and economic correlates of bed-sharing have been identified. There is less bed-sharing by mothers with some college education than by mothers with a high school education (Wolf and Lozoff, 1989). Black US children are more likely than white US children to fall asleep with a caregiver present, to have their beds in their parents' room, and to spend all or part of the night bed-sharing with their parents (Lozoff et al., 1984).

In a study reported by Abbott (1992), childcare practices in a sample of 107 mothers from eastern Kentucky were investigated. In this sample, 36% of infants shared their parents' bed as newborns, and 48% shared their parents' room. Over 65% of infants from this community slept with or near their parents through the first two years of life (Abbott, 1992). The literature suggests that Appalachian families in eastern Kentucky, and other southern Appalachian families, tend to socialise their children toward greater interdependence on the family, and parent-child co-sleeping is seen as part of the pattern that includes nurturant, pro-family value orientations which ultimately result in increased attachment to parents in adulthood (Abbott, 1992). For as Verna Mae Slone, a 75 year old Kentucky woman, expressed in her autobiography 'Common Folks' regarding her feelings about co-sleeping with babies and children,

> '..how can you expect to hold onto them later in life if you begin their lives by pushing them away?' (Slone, 1978, p. 60).

Practices in the United Kingdom

Sharing the parental bed is not considered a routine child care practice in Britain where the advice of child health professionals draws upon research findings that consider frequent bed-sharing to be closely intertwined with child sleep problems (Heron, 1994; Jackson, 1999). Estimates of 'routine' practice vary with different study definitions and the different age bands of the infants being investigated.

A recent, large population-based study, provides a snap-shot of where the infant slept on a particular night. The CESDI SUDI study is one of the first epidemiological investigations of cot death since the dramatic reduction in SIDS rates and covered a third of the English population (18 million). The median age of the 1300 control infants was 14 weeks (interquartile range 9-21 weeks) and comparison of these families with the census data for Great Britain showed a similar breakdown in socioeconomic status (Leach et al., in press). As well as 'routine' sleeping practice, a specific 'day-time' or 'night-time' sleep was chosen in the 24 hours before interview to match the final sleep of the SIDS infants (Blair, P., personal communication). Despite the lack of encouragement from health professionals, the results suggest a much greater proportion of parents (31.5%) bed-shared for at least part of the night. The most common practice amongst parents in England is to room-share but not bed-share, whilst about a quarter of infants slept in a separate room from their parents. A breakdown restricted to the night-time sleep of 1095 control infants (84.2%) is given in Table 3.1.

Table 3.1 Infant Sleeping Place on a particular night: Results from the CESDI SUDI study.

Infant Sleeping Place	N	Percentage
Shared parental bed, put back in cot before end of sleep	166	15.2%
Shared parental bed for whole night or placed in bed during night and found there at end of sleep	179	16.3%
Room-shared in parental bedroom but didn't bed-share	456	41.6%
Slept in separate room from parents, alone or with siblings	290	26.5%
Shared a sofa with parent	4	0.4%
N = 1095 controls		

Results printed with permission by Dr Peter Blair, Medical Biostatistician, CESDI SUDI Study 1993-96.

A study by Heron (1994) addressed the failure of previous studies to distinguish between different levels of frequent bed-sharing. From the literature, Heron identified those families who choose to bed-share all night, every night, as an approach to night-time parenting as 'non-reactive' bed-sharers. Those families who bed-share frequently or occasionally in response to child behaviour or underlying family circumstances, and not necessarily by willing choice, were identified as 'reactive bed-sharers'. The aim of his study was to investigate those families who bed-shared with their children *non-reactively* or 'all night, every night' from birth; to compare their attitudes towards and recollections of bed-sharing, and their child's behaviour (night and day) with other families, across a scale of bed-sharing from 'Never' to 'Always All' (i.e. 'never bed-shared' to 'bed-shared all night, every night'). Heron's investigation of bed-sharing practices was one of the first to address the subgroup of parents who choose to bed-share all night, every night during their child's early years, and the possible stabilising influence that this may have on the child's sleep behaviour.

Heron (1994) devised questionnaires to measure the frequency of bed-sharing, the prevalence of a child's day and night behaviour disturbances, and the attitudes toward bed-sharing by families with a child between 1 and 4 years of age (n=40). The sample was Caucasian and predominantly composed of mothers who were members of the La Leche League (n=19) or who had attended National Childbirth Trust classes (n=18). The sample's demographics largely represented an educated, middle class population, and was purposively selected to include families who were members of groups who were known to promote specific parenting styles, including breastfeeding (e.g. National Childbirth Trust, La Leche League) and bed-sharing (e.g. La Leche League). The majority of parents (75%) reported bed-sharing with their children. Almost half of the sample (45%) always bed-shared with their young children (all or part of the night); of these 71% attended La Leche League. Of those who bed-shared 'frequently' or 'occasionally', only one family reported that when bed-sharing it was for all of the night. Bed-sharing for special reasons was reported by 28% of the group, the most common reasons being child illness (40%); the child awakened during the night (33%) and the child was frightened or worried (20%). The results revealed that when non-reactive bed-sharers are recorded separately from those who bed-share frequently and those who bed-share every night for part of the night, the level of a child's sleep disturbance is significantly reduced ($F=3.75$, $p<0.05$), matching that of non-bed-sharers. No significant difference was found in the daytime measures. Qualitative data showed a difference in attitudes to child care between those families who bed-share all night, every night ('non-reactive' bed-sharers) and those who bed-share every night for part of the night ('reactive' bed-sharers). These results are supported by findings reported by Crowell and colleagues (1987). In their sample of 100 toddlers, the children of the three families who were advocates of the family bed, bed-sharing 'all night, every night' from birth showed no unusual sleep habits or problems. It was discussed how such differences could reflect the non-reactive bed-sharers' commitment to a 'family bedroom' ethos, which promotes night-time continuance of parent-child nurturance (Heron, 1994).

This 'family bed' ethos, is very similar to the philosophy of parenting known as 'Attachment Parenting' practiced by many families in the West, with a strong following in the USA (Sears and Sears, 1993; Dettwyler, 1997). This approach acknowledges that human infants and children have legitimate needs, physical, emotional and nutritional, that should be met by parents in order to have happy, healthy, well-adjusted children. Attachment parenting includes breastfeeding until the child no longer needs to breastfeed (from 3-7 years typically), parent-child bed-sharing until the child decides to sleep in his or her own bed; infant-wearing with a sling or backpack during the first few years of life, and lots of physical and emotional affection. Infants are not left to cry, nor are they encouraged to sleep through the night from an early age. For these families bed-sharing is not a problem or sleep disorder, it is a way of life.

A study in the north-east of England by Hooker (1995) investigated parent-infant sleeping practices in a sample of 59 families, and whether parents in this area would consider embracing alternative infant care practices if research studies suggested that the risk of Sudden Infant Death Syndrome could be reduced by doing so. In this study which included a mainly white population (96%), the proportion of children, aged 0 to 4 years, who had been taken into the parental bed to sleep was 88%. However, the frequency of bed-sharing was described mainly as occasionally (38.5%) and an isolated occurrence (28.8%) with bed-sharing 'all night, every night' occurring among only 7.7% of the respondents. When parents were asked whether they would bed-share if research indicated that this practice could reduce the risk of cot death, 40% said that they would; 51% answered maybe, leaving 9% who said definitely not. The participating parents' understanding of the major causes of cot death were considered to be overheating, chemicals in mattresses, and sleep position (Hooker, 1995). It should be noted that public attention had been focused on the 'toxic gas theory' of cot mattresses (Blair et al., 1995) as a cause of SIDS at the time of this study.

In a further study employing a prospective design, Ball, Hooker and Kelly (in press) investigated the attitudes and practices of new and experienced parents regarding night-time infant caregiving, before and after birth, in an economically depressed, post-industrial community in the northeast of England. Using semi-structured interviews with mothers or couples, this study allowed data on parents' expectations, opinions and intentions before birth to be compared and contrasted to actual parental child care practices after the birth, with regard to infant feeding, sleeping arrangements, infant illness and sources of parental information. Of the 40 families who completed the second interview, 23 were new parents, and 17 were experienced parents (defined by a parity of

1 or more children, excluding current pregnancy). First-time parents were approximately 5 years younger than experienced parents, while similar proportions of both groups included at least one smoking parent within the family (19% of new parents Vs 18% of experienced parents). This study found that night-time parenting strategies at two to four months after the birth of the baby were very different from parents' prenatal expectations. Bed-sharing practices were grouped into habitual 'all night, every night' bed-sharers; habitual 'part night, every night' or 'combination' bed-sharers; occasional bed-sharers (once per week or less), and babies who never bed-shared.

None of the new parents had anticipated bed-sharing with their infants, however at the postnatal interview 70% were found to be bed-sharing at least occasionally. Two babies bed-shared all night, every night; eleven were combination bed-sharers; and five babies slept with parents occasionally. The five babies who had never slept in their parents' bed were all formula fed from birth. Over a third (35%) of experienced parents acknowledged that they would, or might, co-sleep prior to delivery, while 59% of this group actually did so. Two of these newborns were habitual 'all night, every night' co-sleepers, five were combination co-sleepers, and included one set of twins, and four babies slept with parents occasionally. Seven sets of experienced parents reported never (or 'not really') letting their babies sleep in their bed. All new parents had planned to share a room with their baby after birth, with the majority anticipating that this would be for 1 to 3 months before moving the infant to another (separate) room. Most experienced parents (88%) planned to room-share, however they expected infants to remain in the parental bedroom for longer, at least 4-6 months, with a couple of families planning on a year to eighteen months. At two to four months, the majority of new parents were still room-sharing, although 13% had moved their infant into a separate room within two weeks of birth. Infants were most often brought into bed with both parents, but parents having to cope alone at night also reported that co-sleeping was a strategy they commonly employed. There was a trend for the prevalence of all night co-sleeping to increase in the event of temporary absence of one parent, consistent with the findings of Lozoff and colleagues (1984), Schachter et al. (1989) and Forbes et al. (1992), but in this study this trend was not restricted to the absence of fathers.

The results of this study by Ball et al. (in press) indicate that for both new and experienced parents in the northeast of England, co-sleeping was a relatively common practice. Despite preconceptions to the contrary, and fears of overlaying, new parents were found to bed-share with their infant for a variety of reasons including ease of breastfeeding; desire to monitor the infant; parental need for more sleep; desire for closeness; and inability to settle the baby alone. Experienced parents who had co-slept with a previous infant were willing to repeat the practice. The authors concluded that parent-infant co-sleeping is a more prevalent practice in Britain than has been generally recognised.

The results of this study by Ball, Hooker and Kelly (in press) support those reported by Blair et al. (personal communication) from the CESDI SUDI study, in that the practice of bed-sharing is more common in British communities than previously thought. How much more common is difficult to quantify. At first sight there appears to be quite a discrepancy of point estimation between the two studies (Ball et al.: 70% of new parents, and 59% of experienced parents Vs 31.5% of families in the CESDI SUDI study). Further analysis of the CESDI data with regard to infant age also indicated that the prevalence of bed-sharing for infants of 2-4 months of age was 31.1%, the same prevalence as reported for the entire control group (31.5%) (Blair, P., personal communication). However the discrepancy between the two studies is more likely to be a result of definitions rather than quantification. Ball et al. (in press) examined 'routine' practices which depended both on the number of nights per week, and the number of hours per night, used to define bed-sharing. The CESDI SUDI study takes a snap-shot of practices on one particular night. This lack of standardisation makes comparison difficult, not just between these studies, but all studies. Other variants that will affect any estimate of prevalence include the age of the infant sample and how representative these infants are of the general population.

These studies highlight the need for collaboration between researchers investigating co-sleeping, particularly with regard to defining bed-sharing practices. There are methodological problems with comparing findings from the confusing array of literature regarding co-sleeping which uses various definitions to describe a collection of bed-sharing practices; includes children of varying age groups; and which often confounds normal variation in parenting practices with extreme examples associated with trauma and family psychotherapy (Heron, 1994; Trevathan and McKenna, 1994; Ball et al., in press).

Cultural values and expectations have greatly guided perceptions, assumptions, epidemiological questions and interpretations of data with regard to SIDS risk factors. In Japan for example, rather than suspecting that contact with the parent during the night i.e. bed-sharing, contributes to a SIDS death, the assumption is the opposite; when the infant is found to have died alone, it is thought that the solitary environment may have contributed to the death. It is no coincidence that in Japan, where parent-infant co-sleeping and bed-sharing are common that such a prejudice exists, just as it is not surprising that in Western societies, evidence suggests that it has been hard to accept the fact that a SIDS death in a parental bed is not due to overlaying, but rather independent of the parents' proximity (McKenna, 1995a).

Epidemiology of SIDS and the association with Bed-sharing

Studies investigating the epidemiology of SIDS from a number of countries, including the United Kingdom (Carpenter, 1972; Fleming et al., 1996; Fleming et al., in press), New Zealand (Mitchell et al., 1993), Finland (Rintahaka and Hirvonen, 1986), Sweden (Norvenius, 1987), Russia (Kelmanson, 1993) and the United States (Luke, 1978; Bass et al., 1986) have reported deaths from SIDS occurring when the infant was sharing a bed with another person. In many of these cases, parental sedation, including alcohol or drug ingestion, as well as obesity and fatigue, have been implicated, suggesting a mechanism related to accidental infantile asphyxia (Bass et al., 1986; Rintahaka and Hirvonen, 1986; Gilbert-Barness et al., 1991; Fleming et al., in press).

The association between alcohol, bed-sharing and SIDS

Two case-control studies during the 1970's, one in England (Carpenter, 1972) and one in the United States (Luke, 1978), found that bed-sharing was more common in cases than in controls. In the US study, which included 92 deaths certified as SIDS in a four year period, a disproportionate number of deaths when bed-sharing occurred at weekends (36.4%) (16 of the 44 bed-sharing cases) (Luke, 1978). The authors of both of these reports speculated that the association between bed-sharing and SIDS could be due either to the infant being taken to bed for comforting because of minor illness causing restlessness (Carpenter, 1972), or to asphyxia from overlaying, possibly worsened by parental consumption of alcohol or other drugs (Luke, 1978). Luke (1978) suggested that a parental desire to sleep late on weekends, increasing the likelihood of a crying infant being brought into the parental bed, may possibly interact with weekend consumption of alcohol, as an explanation for the increased frequency of SIDS deaths at weekends. As previously discussed in Chapter 2, the role of parental alcohol consumption in overlaying was noted by Templeman as early as 1892 when he observed that 46% of infant deaths in Dundee occurred on Saturday nights when alcohol intake was high (Templeman, 1892).

Two case series in the 1980s, conducted in the United States and in Finland, further supported the role for accidental asphyxia, possibly due to overlaying (Bass et al., 1986; Rintahaka and Hirvonen, 1987). However Bass and colleagues (1986) reported that in their study only one case of infant death could be attributed solely to overlaying. In the other five cases in which overlaying was suspected, the evidence was less convincing, with maternal factors including drug abuse, seizure disorder, obesity and extreme fatigue contributing to overlaying as a cause. In addition, in the Finnish study (Rintahaka and Hirvonen, 1987), alcohol consumption, infant illness and changes in parental behaviour at weekends were also implicated in the deaths occurring during bed-sharing with the infant.

The association between bed-sharing and SIDS in New Zealand

In New Zealand mortality rates from SIDS were high by international comparisons, with the Maori SIDS rate more than three times that of non-Maori (Mitchell et al., 1993; Scragg et al., 1995). Amongst the Maori population bed-sharing is a culturally accepted practice, however smoking, high alcohol intake and socioeconomically disadvantaged living conditions are also common. Results from the first year of the New Zealand Cot Death study, a large, nationwide case-control investigation, identified prone sleeping position, maternal smoking and not breastfeeding to be three risk factors for SIDS which were potentially amenable to change (Mitchell et al., 1991). In 1992, following analysis of the three year data set, bed-sharing was identified as a fourth major risk factor for SIDS and included in New Zealand's national risk reduction campaign (Mitchell et al., 1992, Scragg et al., 1993). The national cot death prevention programme began publicly advocating taking babies out of their parents' beds (Tipene-Leach, 1995).

On subsequent analysis of the data it became clear that this risk only applied to the Maori population, and not to infants of European or Pacific Island Polynesian origin (Mitchell et al., 1993; Scragg et al., 1993). In fact the Pacific Islanders had the highest rate of bed-sharing in one study (42.2%), yet had the lowest SIDS rates (Borman et al., 1988; Tuohy et al., 1993; Mitchell et al., 1997), and interestingly were noted to place their infants *on* rather than *in* the parental bed (Tuohy et al., 1993).

The initial finding that bed-sharing was a risk factor for Maori but not non-Maori led to a suggestion that advice not to bed-share should be given to Maori mothers only. However in a further multivariate analysis, the increase in risk of SIDS associated with bed-sharing was found to apply only to infants of parents who smoked (Mitchell and Scragg, 1993; Scragg et al., 1993), and maternal smoking prevalence was higher in Maoris compared to non-Maoris (Scragg et al., 1995). In addition, the risk of SIDS has been reported to increase with duration of bed-sharing, particularly for smokers (Mitchell and Thompson, 1995). Recommendations in New Zealand were proposed based on these results advising parents to share the same bedroom as their infants; not to bed-share if their mother is a smoker; and that bed-sharing, even if the mother is a non-smoker, cannot be recommended (Mitchell and Thompson, 1995).

Since then, the identification of an interaction between bed-sharing and maternal smoking has prompted further discussion amongst health professionals and parent groups involved with infant care in New Zealand as to whether advice not to bed-share should be given for all infants or only for infants of mothers who smoke (Cowan, 1995; Eastwood, 1995; Scragg, 1995; Scragg et al., 1995; Sugrue, 1995; Tipene-Leach, 1995; Scragg, 1996).

The interaction between bed-sharing and smoking

Recent research, investigating risk factors following risk reduction campaigns both in the United Kingdom and New Zealand, has shown that bed-sharing for the whole night is associated with an increased risk only if the mother is a smoker or has consumed alcohol or other drugs, legal or illegal, which may have an effect on parental sleep behaviour

(Fleming et al., 1996; Mitchell et al., 1997; Blair et al., in press; Fleming et al., in press). The vast majority of bed-sharing mothers whose baby died of SIDS were smokers (86.2%) and the associated risk to infants of these mothers was extremely high (OR 21.13; 95% CI 9.36 to 48.55), whilst not statistically significant amongst infants of non-smoking mothers (Fleming et al., 1996). The most recent report from the CESDI SUDI study, a three year population based case-control study in the United Kingdom, found no evidence that bed-sharing for the whole sleep was a risk factor for SIDS amongst non-smoking parents or amongst infants older than 14 weeks. The multivariate analysis from this study also showed no increased risk of SIDS for infants of parents who bed-shared and placed their infant back in the cot. There was an increased risk of SIDS associated with bed-sharing for younger infants if the parents had recently consumed alcohol; the household was overcrowded; the parents were extremely tired; or the infants were placed under an adult duvet (Blair et al., in press).

A study by Klonoff-Cohen and Edelstein (1995) in California also found no evidence of any significant relationship between bed-sharing and SIDS in their sample of 200 infants who died of SIDS and 200 living controls matched for age, sex, race and hospital of birth. At death, 45 infants (22.2%) were sharing a bed with a parent (35 sleeping together, 4 sleeping in mother's arms) or babysitter (6). In this study, routine bed-sharing was assessed independently for day and night. Daytime bed-sharing was most common in African-American and Latin American families compared to white households. African-American and Asian cases were also more likely than white infants to share a bed at night, consistent with the findings of previous studies (Lozoff et al., 1984). Interestingly, this study did not find an interaction with bed-sharing and passive smoking or alcohol use by either parent (Klonoff-Cohen and Edelstein, 1995).

The protective effect of room-sharing

In New Zealand (Scragg et al., 1996; Mitchell et al., 1997) and the United Kingdom (Blair et al., in press, Fleming et al., in press) sharing a room with a parent has been shown to have a possibly protective effect against SIDS, whilst the practice of infants sleeping in a separate room from their parents has been associated with an increased risk.

In the New Zealand study, infants who slept in a room alone were reported as nearly four times more likely to die from SIDS as infants who shared a room with an adult(s), but this protective effect did not generalise to room-sharing with siblings (Scragg et al., 1996). The CESDI SUDI study also showed that infants who slept in a separate room from their parents demonstrated an increased risk of SIDS (OR=10.49 [95%CI : 4.26-25.81]). Interpretation of the actual risk is difficult, however, as nearly a third of the deaths and matched reference sleeps of the control infants occurred during the day when the sleep routine would obviously be different to night-time practices. Further research is required to investigate whether room-sharing is protective in itself or merely a marker for hidden confounders not yet identified and measured (Blair et al., in press).

Risks associated with sofa-sharing

A recent report from the CESDI SUDI study has also emphasised the potential hazard of adults sleeping on a sofa or couch with a baby; a practice which was involved in more than one in twenty deaths [Multivariate Odds Ratio 25.86 (6.72-99.40)]. (Blair et al., in press, Fleming et al., in press). Many previous studies have failed to distinguish between bed-sharing in a bed, and a parent and infant sleeping together on a sofa, which makes the examination of risk factors associated with 'bed-sharing' even more problematic. As McKenna (1998) points out,

> 'the vertical side of a sofa against which infants can be pinned during sleep can cause the infant to slip face down into a wedge at the back of the cushion and suffocate. Because SIDS and suffocation are difficult to distinguish, such a death could be a proxy for a 'bed-sharing SIDS' when in fact it was more likely suffocation. This definition of bed-sharing illustrates even more why simple generalisations or conclusions about the supposed universal risks of 'bed-sharing' must be limited to particular circumstances and/or populations' (McKenna, 1998, p. 664).

Studies investigating the epidemiology of SIDS have not found direct evidence of any 'protective' effects of bed-sharing. Bed-sharing encompasses a wide range of practices even within relatively homogeneous, well-educated, predominantly white, middle class study groups (Heron, 1994). Some aspects of bed-sharing in cultural groups for whom this is an accepted approach to childcare are likely to be different from groups for whom this practice is not the cultural norm. Cross-cultural (Lozoff et al., 1984; Morelli et al., 1992; Farooqi et al., 1993) and descriptive studies (Gantley et al., 1993; Nelson and Chan, 1996) of infant care practices have all studied families in which bed-sharing is the accepted sleeping environment and the prevalence of maternal smoking is very low (Nelson and Chan, 1996). Bed-sharing amongst socioeconomically disadvantaged groups in a Western society, within which smoking and alcohol use are common and breastfeeding is rare, may be accompanied by risks related to the environment in which it occurs (e.g. on sofas or couches, where there is a risk of entrapment of infants). Therefore, as McKenna (1995a; 1998) and Blair and colleagues (in press) have argued

> '... it is not bed-sharing *per se* that is hazardous, but rather the circumstances in which bed-sharing occurs. That some of these circumstances may be modifiable has important implications in terms of social policy and health education' (Blair et al., in press).

Physiological Effects of Bed-sharing, Room-sharing and Solitary Sleeping

Scientific studies have only recently begun to document the physiological and behavioural effects of solitary infant sleep and infants sleeping in contact with an adult. As mentioned previously, the socioemotional, psychological and physiological benefits of solitary sleep for infants had been presumed, and 'benefits' had been defined in terms of parental interests or other cultural values or expectations, or compared to social sleeping occurring under unsafe conditions (McKenna, 1995a).

Studies of bed-sharing in a group of Latino mother-infant pairs carried out by McKenna and his team revealed that, compared to when they sleep alone in separate rooms, a) bed-sharing mothers and infants exhibit high levels of arousal overlap (Mosko et al., 1997a; 1997b); b) infants exhibit more frequent sleep stage shifts or awaken more frequently while bed-sharing, and spend more time, at the same time, in the same sleep stage or awake condition as their mother (McKenna et al., 1990; McKenna and Mosko, 1994); c) bed-sharing infants spend less time in deep stages of sleep (stages 3 or 4), this state being associated with a greater arousal threshold and hence possibly protective against SIDS (McKenna et al., 1990, Mosko et al., 1996); d) bed-sharing infants almost doubled their breastfeeding episodes and episodes were 39% longer in duration (McKenna et al., 1997); and e) bed-sharing infants faced towards their mothers for the vast majority of the night (between 72-100% of the time) (Richard et al., 1996), and these face-to-face orientations together with the close proximity observed between bed-sharing pairs for large portions of the night, potentially expose the infant to elevated levels of carbon dioxide (CO_2) within a range known to stimulate infant respiration and minimise periodic respiration (Mosko et al., 1997c). It was also noted that when bed-sharing, mothers were never observed to place their infants prone (Richard et al., 1996), confirming findings from the recent CESDI SUDI study (Blair et al., in press).

Tuffnell, Petersen and Wailoo (1996) investigated the effect of bed-sharing with one or both parents on the deep body temperature of infants. Overnight continuous recordings of rectal temperature were made from 34 babies bed-sharing with one or both parents throughout the night, and from 34 infants matched for age, sex, feeding regimen, parental smoking, thermal environment and sleeping position, who slept alone. The researchers found that the bed-sharing infants had significantly higher rectal temperature from two hours after bedtime, when the initial fall in sleeping body temperature was complete. The mean rectal temperature of bed-sharing infants between two and eight hours was 0.1°C higher than that of infants sleeping alone ($p<0.04$). The researchers proposed that the simplest explanation for the higher rectal temperature of the bed-sharing infants is the thermal coupling between the infant and the parent(s) in bed. As the infant is next to another warm body, it is less capable of losing heat, thus increasing rectal temperature. These researchers concluded that the difference in rectal temperature suggested an altered physiological state resulting from the reduced heat loss of the infant, and even small changes in rectal temperature may indicate large thermoregulatory responses which may affect other physiological systems in the body, including the cardiorespiratory system.

Physiological findings, from the same study in which mother-infant behaviour was observed and is reported in this thesis, have been published previously (Sawczenko et al., 1995; 1996; 1997; Sawczenko et al., in press). The cross-over laboratory design allowed a comparison of infant thermal physiology, thermal micro-environment and CO_2 micro-environment between infants bed-sharing with their mothers, and infants who room-shared; sleeping separately in a cot beside the bed. From 19 pairs of bed-sharing versus room-sharing nights it was observed that when bed-sharing, the infant's micro-environment was warmer, and forehead, abdominal and shin temperatures were higher, however the nadir of rectal temperature was the same or lower. Oscillations of infant body temperature occurred with changes in sleep state, and were not affected by bed-sharing. On some occasions, infant abdominal and forehead temperatures were greater than rectal temperature during very close contact. The maximum inspired CO_2 observed whilst bed-sharing was 2.4% and was not associated with reduced oxygen saturation. There were no significant differences in the number or length of active or quiet sleep periods, total length of infant sleep, or length of nocturnal awakenings, between bed-sharing and room-sharing nights.

Despite differences in thermal environment and evidence of active heat excretion (higher peripheral temperatures), in infants aged 2 to 5 months, rectal temperature was maintained or slightly lower when bed-sharing, suggesting effective thermoregulation. There was also little evidence to suggest that even inadvertent head covering in supine sleeping infants could result in rebreathing of CO_2. The authors (Sawczenko et al., 1998; in press) concluded that their results support the epidemiological findings that in infants of low risk for SIDS, bed-sharing is unlikely to be harmful.

The finding reported by Sawczenko et al. (in press) that rectal temperature is actually the same or lower in bed-sharing infants opposes that of Tuffnell et al. (1996). The strength of the study by Sawczenko et al. was that each infant acted as their own control, on consecutive nights, in identical room temperatures. It is conceivable that the longitudinal nature of this study, in which comparisons were only made between studies on consecutive nights from the same baby, may have masked age specific differences in infant physiology that might occur in response to bed-sharing. The marked changes in thermal physiology during sleep with increasing age preclude comparison, even for the same infant, between bed-sharing and room-sharing at different ages (Lodemore et al., 1991). It is also important to note, that as previously shown by Lodemore et al. (1991), infants of the same age are not necessarily at the same stage of physiological development for temperature control. However the same limitation is found in Tuffnell's study. Although age was included in the matching of infants into the room-sharing and bed-sharing groups, the age of the total group of infants in their study ranged from 6 to 16 weeks (Tuffnell et al., 1996).

A study currently being conducted by Ball and Hooker (1998) in the northeast of England is investigating parental strategies for the night-time care of infants. Using infra red video technology in the home situation this study has reported preliminary findings in which ten infants were observed when sharing a bed with both parents (triadic night: three in a bed), and then with mother only (dyadic night: mother and infant bed-sharing). The researchers observed that although breastfeeding and orientation of the mother appeared to be unaffected by the presence of the father, infants aroused more frequently and mothers responded more rapidly to their infants on triadic nights than compared to dyadic nights. Ball and Hooker (1998) claim that these infants did not appear to be at an increased risk of overlaying, suffocation, or overheating when sleeping with both parents compared to sleeping with the mother only. No physiological recordings were made however, so any potential effects of these two environmental conditions on infant physiology and thermal regulation cannot be assessed.

Relationship between Bed-sharing and Sleep Problems

The association of co-sleeping or bed-sharing with sleep problems has been demonstrated in several clinic populations (Lozoff et al., 1984; Kataria et al., 1987; Zuckerman et al., 1987), including pyschiatric out-patient clinics for children referred with behavioural problems. The most common sleep problems described in investigations which addressed childhood sleep disorders were 'night waking' and 'bedtime struggles' (Richman et al., 1975; Lozoff et al., 1984; Askew et al., 1988; Schachter et al., 1989; Forbes et al., 1992; Rapsiardi et al., 1995). Many of these researchers utilised a definition of 'sleep problems' similar to that proposed by Lozoff and colleagues (1985):

> 'A sleep problem was defined as night waking that involved the parents, or bedtime struggles, which occurred three or more nights each week for the preceding month, accompanied by conflict or distress' (Lozoff et al., 1985, p. 478).

Sleep enuresis, early rising and difficulty rousing a child in the morning were sleep related problems less frequently described in the studies reviewed (Adair and Bauchner, 1993). The association between co-sleeping and other behaviour problems is poorly documented because existing studies have methodological shortcomings, including a lack of appropriate control groups (Kaplan and Poznanski, 1974); failure to distinguish occasional from habitual bed-sharing, and room-sharing from bed-sharing (Oleinick et al., 1966); and considering bed-sharing as a sleep problem or behaviour problem in itself (Richman et al., 1975; Richman, 1981).

Traditionally, psychiatric and paediatric advice has been to avoid bed-sharing as much as possible (Spock and Rothenberg, 1985). These prohibitions have not typically been supported by empirical data, but instead are justified on the basis of clinical experience (Forbes et al., 1992). Potential ill effects of bed-sharing which have been cited in the literature, but are not evidence-based, include statements that bed-sharing may create a risk of physical injury to a child from parental movements or even death by suffocation (Medoff and Schaefer, 1993); disturb the parents' sleep due to the child in bed (more movements, noise etc.) (Medoff and Schaefer, 1993); cause or exacerbate child psychopathology (Kaplan and Poznanski, 1974; Behrman and Vaughn, 1980; Rath and Okum, 1995); allow sexual abuse to occur (Walker et al., 1988; Madansky and Edelbrock 1990); frighten or confuse children who inadvertently witness adult intercourse (Ferber, 1985; Spock and Rothenberg, 1985; Madansky and Edelbrock, 1990; Medoff and Schaefer, 1993); overstimulate children by close but nonsexual contact (Kaplan and Poznanski, 1974; Madansky and Edelbrock, 1990; Medoff and Schaefer, 1993); reflect, contribute to, or perpetuate difficulties in the marital or parent-child relationship (Kaplan and Poznanski, 1974; Madansky and Edelbrock, 1990; Medoff and Schaefer, 1993); cause jealousy among other siblings not in the bed (Medoff and Schaefer, 1993); reflect parent insecurity or psychopathology (Madansky and Edelbrock, 1990); interfere with the development of the child's independence and autonomy (Madansky and Edelbrock, 1990; Medoff and Schaefer, 1993); reinforce a child's negative behaviour and become a habit that is hard to break (Madansky and Edelbrock, 1990; Medoff and Schaefer, 1993); be associated with sleep problems (Lozoff et al., 1984; Zuckerman et al., 1987; Schachter et al., 1989; Madansky and Edelbrock, 1990); and cause a reduction in the 'off duty' or private time for the parent (Medoff and Schaefer, 1993).

However several studies have cast doubt on these traditional prohibitions. Oleinick et al. (1966) compared children in each of three settings; public school children, paediatric clinic patients and psychiatric clinic outpatients, and did not show significant intergroup differences in co-sleeping behaviour. This study did not however distinguish between regular and occasional co-sleeping, or sleeping in the same bed from sleeping in the same room. Additional studies have demonstrated bed-sharing to be a common behaviour in healthy middle class American families (Hanks and Rebelsky, 1977; Rosenfeld et al., 1982), and positively related to indices of sexual and interpersonal adjustment in a survey of undergraduate psychology students (Lewis and Janda, 1988).

Proponents of bed-sharing and 'the family bed' (Thevenin, 1987; Medoff and Schaefer, 1993; Sears and Sears, 1993; Dettwyler, 1997; Jackson, 1999) have put forward several motivations and benefits of the practice including the belief that young children need 24 hour closeness with their mother; the convenience of breastfeeding; easier night-time management; fulfilment of the maternal protective and mothering instinct; reduction in night fear and awakenings; and the belief that bed-sharing creates happy, secure, and ultimately less dependent children (Thevenin, 1987; Dettwyler, 1997). McKenna and colleagues (1993), as discussed previously, propose that co-sleeping parents may assert protective physiological regulatory effects on their infants through the continuous sensory exchange which occurs between co-sleeping pairs. Many of these authors have promoted the positive effects of this close and continued contact at night on self-esteem and discipline, and have noted that most children desire their own space by age three to six, and that, with a well established sense of security, the need for privacy and separateness becomes more important to the child (Sears and Sears, 1993; Thevenin, 1987; Jackson, 1999).

Several differences in the prevalence and pattern of co-sleeping or bed-sharing have been consistently found, however there still remains disagreement among studies about the relationship between bed-sharing and childhood sleep problems (Lozoff et al., 1996).

British community studies conducted by Richman and colleagues (Richman et al., 1975; Richman, 1981) reported an increased prevalence of co-sleeping in young children with sleep problems. These studies however confounded the issues by including sleeping with parents as part of the definition of the sleep problem, as the main aim of both of these studies was to investigate the prevalence of behavioural problems in pre-school children.

Kaplan and Poznanski (1974) investigated co-sleeping practices in an outpatient psychiatric population. The results are limited due to a lack of control group and the vague definition of co-sleeping, however the authors report some interesting findings. Of the 700 records reviewed only 60 children shared a bed with a parent, and of these 27 frequently bed-shared. There was a non-significant prevalence of co-sleeping among families of lower socioeconomic status. The 8 girls who frequently shared the parental bed came from two parent families, while all of the single parent families in the study included boys who bed-shared. Kaplan and Poznanski (1974) considered it possible that the mother often used the child's presence as a defence against her husband's sexual demands, and advised that where it was noted that a boy shares the mother's bed, clinicians could

> 'entertain with some confidence that there is marital discord between the parents of a male child who sleeps with his mother, unless clinical investigation of the individual case proves otherwise' (Kaplan and Poznanski, 1974, p. 352).

However Klackenberg (1982), reporting on a longitudinal sleep behaviour study of families in Sweden, did not find a higher divorce rate among families that co-slept with children between the ages of 4 and 8 years. Neither was there any significant covariation between annual findings on the parent's marital relations and children sleeping in the parental bed at 6-9 years of age. This study of 212 children found that part-night bed-sharing occurred in 40% of 2 year olds, and 50% of three year olds, which gradually declined to 10% of 7 year olds and nearly 0% of 11 year olds. Fear of the dark and co-sleeping were significantly associated at 7, 8 and 10 years of age. Klackenberg (1982) concluded his paper by stating that the practice of co-sleeping was too widespread among ordinary families for it to serve as a sign that parents are in the process of separating.

Forbes and colleagues (1992) examined the bed-sharing habits of 86 children from military families, aged 2 to 13 years, who experienced frequent absences of their father, and specifically aimed to assess whether conflict arose in male children who shared their mother's bed. Bed-sharing was common in the military family, and more girls co-slept than boys. More of the children co-slept during their father's absence, and those who co-slept when their fathers were present, did so more frequently in their father's absence. Only 30.2% of the cases surveyed did not bed-share in their father's absence. Single mother headed families and step families bed-shared less frequently than two parent households, which contrasts with Schachter et al. (1989) who found bed-sharing to be more frequent in single parent Hispanic families. Contrary to the authors' expectations, children who had not had previous professional attention for emotional or behavioural problems bed-shared more frequently than did children who were known to have had psychiatric intervention and lower parental ratings of adaptive functioning (Forbes et al., 1992). The authors suggested that the high percentage of reported bed-sharing in the face of paediatric and psychiatric prohibitions may indicate that experience has taught parents that under certain conditions bed-sharing is a benign practice and that advice to the contrary can be ignored. In addition, Forbes and colleagues discussed how bed-sharing may be an adaptive response in these military families; the family growing temporarily more consolidated, as if for protection, while the father is absent. The behaviour therefore has more of a nurturant purpose in these families which outweighs any potential conflict in male children or any loss of autonomy or individuation which could occur in either gender (Forbes et al., 1992).

Rath and Okum (1995) performed an archival review of co-sleeping which involved a total of 207 children who had presented for evaluation or treatment at an outpatient mental health centre, and ranged in age from 5 to 18 years. The authors suggested that co-sleeping prevalence has been underestimated in the literature and that co-sleeping is associated with child and parent anxiety and issues of separation and sleep management, rather than inappropriate sexual contact (Rath and Okum, 1995). Interestingly, these authors constructed their research options for 'suspected causes of co-sleeping' (Rath and Okum, 1995, p. 415), which pathologises co-sleeping, when it can be argued that co-sleeping or bed-sharing is the physiological, evolutionary and cultural norm for our species (McKenna et al., 1993; Dettwyler, 1997).

Lozoff and colleagues provide some of the most comprehensive data on co-sleeping behaviour to date (Lozoff et al., 1984; Lozoff et al., 1985; Askew et al., 1988; Lozoff et al., 1996). In this large, random sample (n=150), representative of the demographic characteristics for census data in the Cleveland area, co-sleeping or bed-sharing was routine and recent in 35% of white families and 70% of black families. Bed-sharing in both groups was associated with approaches to sleep management at bedtime which emphasised parental involvement and body contact. An association was found between bed-sharing and childhood sleep problems among whites, but not among the black population. In white families bed-sharing was significantly correlated with increased age of the child, a lower level of parental education and occupational skills, family stress, ambivalent maternal attitude towards the child, and disruptive sleep problems including night waking and bedtime struggles. None of these findings were significant for black families, and in fact the relationship was found to go in the opposite direction. There was an increase in sleep problems in black children who did not routinely bed-share, but this failed to reach significance (Lozoff et al., 1984).

A follow up study conducted by Lozoff and colleagues in 1985 confirmed the finding of significantly increased sleep problems in co-sleeping (bed-sharing) white children (Lozoff et al., 1985). Using data from the white Caucasian population of their previous pilot study and an additional randomised group of healthy, Caucasian children as their validation group, Lozoff and colleagues (1985) found that in the total sample of 96 white children, aged between 6 months and 4 years, 70% of the children with sleep problems slept in their parents' bed all or part of some nights one month prior to the study, as compared to 23% of the sample without sleep problems. Five experiences distinguished children with sleep problems from those without, and these were: 1) an accident or illness in the family; 2) unaccustomed maternal absence during the day; 3) maternal depression; 4) sleeping in the parental bed; and 5) maternal attitude of ambivalence towards the child. The authors concluded that night waking and bedtime struggles are behaviour patterns which could alert paediatric health professionals to the existence of more pervasive disturbances in the child and family (Lozoff et al., 1985).

In order to substantiate findings regarding sleep problems seen in white bed-sharing children, as opposed to the lack of difficulties associated with bed-sharing in black children, Askew, Lozoff and Wolf (1988) conducted a study to compare co-sleeping (bed-sharing) among black and white families. Utilising data from 60 additional interviews with mothers of black children, data from 90 black subjects were compared with 96 white subjects in the original Lozoff et al. (1984) study. The authors confirmed all but one of their original findings. Askew and associates (1988) found that maternal ambivalence was a bed-sharing correlate in black families as well.

In a more recent study published in 1996, Lozoff and colleagues (1996) addressed ethnic and socioeconomic differences in the relationship between co-sleeping and sleep problems. The sample consisted of 186 urban families with healthy children aged 6 months to 4 years and was divided into four groups: white lower socioeconomic status (SES); white higher SES; black lower SES and black higher SES. Regular co-sleeping was associated with increased night waking and/or bedtime protests among lower SES white children and higher SES black children. Among families who co-slept, white parents were more likely than black parents to consider their child's sleep behaviour to be a problem. One explanation proposed is that differing childrearing attitudes and expectations influenced how parents interpreted their children's sleep behaviour (Lozoff et ., 1996). The authors concluded that within the USA, there are subcultural differences in the practice of co-sleeping (bed-sharing) and its correlates, and that paediatric recommendations should reflect consideration of such cultural differences.

An explanation for Lozoff and colleagues' (1984; 1996) finding that co-sleeping is less likely to be associated with sleep problems in black families, put forward in discussions by Madansky and Edelbrock (1990), Medoff and Schaefer (1993) and Heron (1994), is that many black families slept with their infants from birth and move the children to their own sleeping quarters when they were older. This 'non-reactive' bed-sharing may be a subcultural family pattern that is not associated with child sleep problems; it represents a custom and not a parental solution to the child's sleep difficulty. In focusing on 2 and 3 year olds, Madansky and Edelbrock (1990) hypothesised that in their study, in which they did find an association between bed-sharing and sleep problems such as bedtime struggles and night waking in the non-white population, they may have sampled the 'reactive bed-sharers', who do so in response to child behaviour or underlying family circumstances.

Madansky and Edelbrock (1990) provide further support for the association between co-sleeping and child sleep problems in toddlers, although no information regarding cause-effect relationships. Co-sleeping in this study was synonymous with bed-sharing.

Children who continued frequent co-sleeping one year following the initial assessment maintained higher levels of sleep problems compared with those who stopped co-sleeping and children who did not co-sleep. Co-sleeping was significantly correlated with absence of the father, a trend also noted by Lozoff et al. (1984). There was also a significant decline in sleep problems in children who stopped frequent co-sleeping and a significant increase in sleep problems in those who began frequent co-sleeping. The authors concluded that co-sleeping is common amongst toddlers; not significantly related to child behaviour problems; and not related to general maladjustment, although frequent co-sleeping was closely intertwined with child sleep problems.

In another partial replication of the study conducted by Lozoff et al. (1984), Schachter and colleagues (1989) investigated co-sleeping patterns of urban Hispanic American children and compared them with the white sample of children used in the Lozoff study. Using the same criteria for co-sleeping as previously described in the Lozoff study, this study found the overall totals of co-sleeping for white (n=83) and Hispanic samples (n=210) were quite similar (44.9% and 41.4%, respectively). Significant differences were observed regarding frequent all night sharing of the parental bed between Hispanic and white urban families (21% versus 6%, respectively) as well as sharing the parental bedroom (79% versus 10%, respectively). Sleep problems were found only in the frequent, all-night co-sleeping children and were not associated with the common practice of room-sharing with parents. Co-sleeping was significantly more common in single parent Hispanic families and interestingly, few families with infants under one year of age participated in co-sleeping. Both of these findings are consistent with results from the study by Lozoff et al. (1984). The latter finding provides further support to the view that these studies are sampling families who are co-sleeping reactively, in response to childhood sleep difficulties.

Rapisardi and colleagues (1995) investigated bed-sharing practices in young Italian children. Co-sleeping in this study was defined as sleeping in the parental bed. A large sample of 1414 children aged 4 months to 6 years was subdivided into four groups based on routine sleep behaviour: ‘no co-sleepers’; ‘partial co-sleepers’, who slept with parents less than half the night; ‘co-sleepers’ who slept with parents more than half the night; and ‘super co-sleepers’ who slept with parents the whole night. The global prevalence of co-sleeping, children sleeping in the parental bed for at least some of each night, was 41% and was strongly associated with sleep problems, including frequent night waking and bed-time struggles. Compared with no co-sleepers, partial co-sleepers and co-sleepers were more likely to have night wakings, bedtime struggles, resistance going to bed, and longer time to fall asleep. On the contrary the super co-sleeping children (6% of the total sample, with a peak of 9% from 2 to 4 years) did not differ from the children who never co-slept, except in the need for a longer time to fall asleep and were more likely than the rest of the population to have less night wakings (Rapisardi et al., 1995).

The exact nature of the relationship between bed-sharing and sleep problems has yet to be determined. The findings from the few studies which provide data on this subject cannot be interpreted in a simple way. This is because randomised studies include parents who often accept infants into their beds in response to existing sleep problems, rather than as a favoured, preferred or elected infant sleep management strategy. The result is that many parents who permit children into their bed do not accept the values which define this behaviour positively. These parents view this behaviour as a last resort strategy, and as an indication of their own deficits, or as deficits in their children. Many of these parents assume bed-sharing is detrimental in the long run and so practice an erratic pattern of bed-sharing, therefore often reinforcing or worsening the problem (Madansky and Edelbrock, 1990; Trevathan and McKenna, 1994).

Bed-sharing may contribute to sleep problems by giving positive reinforcement; by delaying solutions to the underlying problem, or by depriving children of the opportunity to achieve regulation of sleep states by themselves (Heron, 1994). Bed-sharing may merely allow parents to be more aware of the child's night-time behaviour, causing them to report more sleep problems; may be a typical response to children with certain types of pre-existing sleep problem; or each may be an independent response to underlying family circumstances (Madansky and Edelbrock, 1990). Conversely, bed-sharing may occur primarily in reaction to sleep disturbances, which might be conceivably worse without such parental response (Thevenin, 1987; Heron, 1994; Jackson, 1999).

When bed-sharing is accepted as a favoured and preferred sleep pattern and infant awakenings are not culturally defined as a 'problem', even when infants or children awaken frequently it is not perceived as a 'sleep problem' (Lozoff et al., 1984; Elias et al., 1986; Abbott, 1992; Morelli et al., 1992; Trevathan and McKenna, 1994). McKenna et al. (1993) present the view that infants and young children who protest against solitary nocturnal sleep are responding adaptively against a potentially life-threatening situation - separation from the caregiver. From an anthropological perspective the frequency of childhood sleep problems in western industrialised countries, reported as high as 30-40%, suggests that culture and children's pyschosocial and biological needs are in conflict (McKenna et al., 1993).

Parents who do not sleep with their children can be seen as 'successful' with their consistency in maintaining parent-infant night-time separation. Parents who sleep with their children 'all night, every night' are also exhibiting a consistency in parenting. Heron (1994) proposes that these polar opposites can be seen as representing subcultural differences in child care practices. The 'all night, every night' group may reflect an emphasis on interdependence and nurturance in family life, as already discussed. In contrast, parents who do not sleep with their children, their aim to foster early independence, can be seen as successful in their application of a Western child care practice. Both of these approaches represent a high level of consistency for the child who, confronted with a stable and repetitive bedtime management, is given no opportunity for sleep disturbance to be positively reinforced by bed-sharing, unlike occasional and frequent bed-sharers (Heron, 1994).

Many of the findings reported in the literature reviewed in this chapter regarding the association between co-sleeping and sleep problems support the opinion of Lozoff et al. (1984), that advice against co-sleeping (bed-sharing) may be oversimplistic, and that more extensive studies are required. In the words of Rosenfeld and colleagues (1982), even when there is evidence of psychopathology in a child who co-sleeps, this is likely to be

> 'one small rent indicative of much deeper defects in the fabric of family life' (Rosenfeld et al., 1982, p. 947).

Effects of Co-sleeping on Later Life Development

To date, psychological studies have contributed more to the understanding of the demographics of co-sleepers than to an understanding of the psychological impact of co-sleeping. Lewis and Janda (1988) were the first researchers to examine adulthood consequences of childhood co-sleeping and found that bed-sharing was positively related to indices of sexual and interpersonal adjustment in a sample of college students. Predictions of psychiatrists were tested in relation to outcomes rated to overall adult functioning and specifically sexual functioning. Both men and women expressed positive sentiments about co-sleeping, including that in their childhood it made them feel safer and more secure. Other findings included increased self esteem; less guilt and anxiety; less discomfort regarding physical contact and affection; and a slight tendency, by both men and women, towards casual sexual relationships; (interpreted by the authors as a sign of comfort with their own sexuality rather than as a negative sign). More positive parental attitudes about sexuality seemed to be related to many of the same variables as co-sleeping, and at least as strongly. There was a lack of findings regarding negative adjustment variables. The authors suggested that equally important in predicting later interpersonal and sexual adjustment as co-sleeping, are the parental attitudes which surround it (Lewis and Janda, 1988). It is possible that parental attitudes are mediating or moderating variables to the effects of co-sleeping.

This study, together with the study by Heron (1994), supports the idea of local (within family) context dependence of co-sleeping or bed-sharing. If a within family context makes a difference in how co-sleeping relates to later development, it seems possible that the broader cultural context, through which all social behaviour is mediated, is also an important factor in how co-sleeping relates to later mental health. The cultural context of these childhood experiences may be important to understanding their later life effects on the child. These kinds of experiences may have very different meanings within a family whose values include beliefs in the 'naturalness' of nudity and sexuality, than in the context of a family who endorses conservative attitudes towards nudity and sexuality (Okami, 1995).

In a study which aimed to investigate the effects of childhood co-sleeping on later life development, Mosenkis (1998) addressed the methodological shortcomings of many previous studies which have not considered the cultural context of co-sleeping. Using data from a larger study which was investigating many facets of adjustment in adults, co-sleeping practices in childhood were related to outcome measures in adulthood in five ethnic groups in Chicago and New York. The groups sampled included Puerto Ricans and Mexicans in Chicago, and Puerto Ricans, Dominicans and native born African Americans in New York. It was hypothesised that co-sleeping should be more normative in these groups. By not including middle class white Americans, this sample allowed confounding effects of the cultural context of co-sleeping to be controlled, and to test for them at the same time by comparing different ethnic groups (Mosenkis, 1998).

To test the hypotheses of the co-sleeping advocates and opponents, four outcome measures were used to compare adults who bed-shared with parents as children with those who did not, using a Rasch Measurement Model for rating scale analysis. These outcome measures included the incidence of depression and mental health treatment (to test whether co-sleeping is related to neurosis and later life psychological problems); relationships with spouses and children (to test whether co-sleeping strengthens family bonds and leads to adults more secure in their relationships, as asserted by co-sleeping proponents); self efficacy and environmental mastery (to test the hypothesis that people who co-sleep are hindered in developing independence, and will always need to cling to others); and overall life satisfaction measures.

The most revealing finding from these analyses was that there was no strong evidence that co-sleeping as a child had negative later life consequences. For the majority, there were no statistically significant relationships, and the relationships that existed tended to be positive. The results indicated that for the populations tested, there was no general truth about later life consequences of co-sleeping. No results held across all groups. There were some negative psychological effects on some groups and some positive ones, but overall there was no net effect. Family relations seem to be improved by the practice as predicted by Thevenin (1987) and Jackson (1999), and the most frequent results showed that co-sleeping had a positive effect on overall life satisfaction.

The study highlights the central claim of cultural psychology regarding the relativism of psychology: in different cultural contexts, the same practice can have different effects on the individual. This study focused on populations for which co-sleeping is culturally accepted, and did not find any strong negative effects. Mosenkis (1998) acknowledged that it was possible that these negative effects do exist in mainstream, middle-class white

America because co-sleeping is not a practice that is as culturally congruent. An important message which Mosenkis (1998) conveyed is that from this study, (the only one found in this literature search which considered effects of co-sleeping in adulthood together with the cultural context of co-sleeping), it is difficult to make strong statements about the effects of co-sleeping on later life development. This is important not only as a 'lack of effect' report, but as a hypothesis test. As Mosenkis (1998) pointed out, strongly worded and definitive claims on the inevitable outcomes of childhood co-sleeping have been made by many health professionals and advice columnists, while advocates of co-sleeping have argued equally strongly to convince parents that co-sleeping is a universally healthy practice. The results of this study imply that co-sleeping advocates and opponents should reconsider the certainty with which they put forward their hypotheses. Co-sleeping is a practice which is closely linked with cultural values, and affects different types of constructs in different ethnicities (Mosenkis, 1998).

Relationship between Bed-sharing and Breastfeeding

A protective effect of breastfeeding against SIDS has not been found universally. Although breastfeeding has been identified in some studies as being protective (Watson et al., 1981; Hoffman et al., 1988; Ford et al., 1993), with some researchers suggesting that the extent of protection may be dose-related (Hoffman et al., 1988; Fredrickson et al., 1993), other studies have shown that breastfeeding does not significantly lower the risk of SIDS, after controlling for socioeconomic status and other significant factors (Fleming et al., 1996; Mitchell et al., 1997).

The lack of any dose-response effect from breastfeeding found in the CESDI SUDI study in the United Kingdom, suggests that breastfeeding may act as a marker of the lifestyle of mothers who breastfeed rather than showing a biological effect in itself. The loss of significance when account is taken either of smoking or of socioeconomic status supports this interpretation, as does the very small protective effect among the infants of non-smoking mothers (Fleming et al., 1996). However it has been proposed that epidemiological studies may have failed to distinguish between the frequency, duration and intensities of breastfeeding as an explanation for why these studies did not show a protective effect (McKenna, 1995b). Mitchell et al. (1997) also comment about the limitations of their most recent study since the New Zealand 'Reduce the Risk' campaign which did not identify an independent protective effect from breastfeeding, in contrast to previous reports from this group (Mitchell et al., 1991; Mitchell et al., 1992; Ford et al., 1993). They point out that breastfeeding rates are high in New Zealand and this study may lack the power to detect a benefit from breastfeeding. They also propose that in countries with a low breastfeeding rate, the potential benefit of breastfeeding on SIDS mortality will be much greater.

However there are many reasons for health professionals to continue to recommend breastfeeding. The benefits of breastfeeding to mother and child are numerous and well documented and include both nutritional and non-nutritional advantages (Ford et al., 1994; Henschel and Inch, 1996). There is also near universal agreement that increased breastfeeding reduces infant morbidity and mortality worldwide (Cunningham et al., 1991; Cunningham, 1995). Despite this, very few clinical, experimental or ethnographic studies have addressed the role that sleeping arrangements play either in promoting or inhibiting breastfeeding practices (McKenna et al., 1997).

The absence of research in this area may be partially explained by Western cultural views which favour early weaning and solitary infant sleep believed to promote infant autonomy (Ferber, 1985; Morelli et al., 1992), and is therefore the cultural context in which paediatric research unfolds. For example, Pinilla and Birch (1993) devised a behavioural strategy, by which, commencing early in infancy, mothers could reduce or even eliminate nocturnal feeds, thereby minimising the need for night-time parental interventions. This strategy is apparently supposed to make the continuation of breastfeeding more convenient and easier for the new mother. In addition, Adair and colleagues (1992) proposed a primary care intervention to reduce night waking in infancy which included parents being advised to put infants to bed partially awake so that the child would learn to go to sleep without an adult being present. They reported that the breastfeeding rate was not reduced in those infants who fell asleep without parental presence (intervention versus control, 16% Vs 19%, $p=0.45$). Research into infant sleeping arrangements have focused on child care strategies that fit in with parental work schedules and preferences, without scientific determination of whether reduced night-time contact with parents represents disadvantages for infants (Woolridge, 1995; McKenna et al., 1997).

Two epidemiological studies investigating risk factors for SIDS in the United Kingdom (Clements et al., 1997) and in New Zealand (Ford et al., 1994) also collected data on factors associated with breastfeeding. Both studies identified bed-sharing as being positively associated with breastfeeding at discharge from hospital, and with a longer duration of breastfeeding. Ford et al. (1994) questioned the cause for the strong association between breastfeeding and bed-sharing: Do breastfeeding mothers find that breastfeeding is best achieved by bed-sharing, or is bed-sharing a consequence of breastfeeding? A letter published by these researchers indicated that 80% of New Zealand mothers sharing a bed with their infant do so for breastfeeding (Mitchell et al., 1994), which suggests that breastfeeding is an inducement for bed-sharing. Clements and colleagues (1997) later commented that the resulting bed-sharing may lead to an increased duration of breastfeeding by providing closer contact and greater opportunity to breastfeed. Both studies concluded that a randomised controlled trial was needed to determine the causal relationship between bed-sharing and breastfeeding (Ford et al., 1994; Clements et al., 1997).

Studies investigating breastfeeding in both nonwestern and western ethnographic settings have collected data through either diurnal observations or from structured interviews or daily feeding diaries which relied upon maternal recall (Konner and Worthman, 1980; Elias et al., 1986; Vitzthum, 1994a; 1994b). However several studies have shown that maternal recall has not proven to be very reliable (Quandt, 1987; Vitzthum, 1994a). For example, Vitzthum (1994a) reported that mothers significantly underestimated the frequency of breastfeeds, while consistently overestimating duration, compared to the researcher's direct observations.

McKenna and colleagues (1997) were the first group to measure directly nocturnal breastfeeding in any cultural group. The most important finding from this study of thirty-five Latino mother-infant pairs observed in their usual sleeping condition, was that routinely bed-sharing infants breastfed approximately three times longer during the night than infants who routinely slept separately. This reflected a two fold increase in number of breastfeeding episodes and 39% longer episodes. Breastfeeding was also facilitated on the bed-sharing night relative to the solitary night within the routinely bed-sharing group; the number and total duration of breastfeeding episodes were significantly larger on the bed-sharing night (McKenna et al., 1997). These researchers concluded that bed-sharing promotes breastfeeding and proposed that these findings have important implications for infant and maternal health in regard to possibly reducing the risk of SIDS, and influencing maternal reproductive physiology.

These findings, from the study conducted by McKenna and colleagues together with the New Zealand reports, indicate a cyclical relationship exists between bed-sharing and breastfeeding: breastfeeding promotes bed-sharing, which in itself promotes breastfeeding. Investigations into fertility after childbirth and birth spacing have also demonstrated the close relationship between breastfeeding and bed-sharing.

Konner and Worthman (1980) reported on infant care practices and their effects on gonadal function and birth spacing in the !Kung Hunter-Gatherers of Botswana and Namibia. Mothers and infants in this culture practise brief, but highly frequent bouts of breastfeeding, with short interbout intervals (mean ± standard error, 13.19 ± 1.28 minutes). Perhaps not surprisingly, the time between pregnancies is longer than in other cultures, the average interval being about four years. The !Kung also sleep with their babies at night, during which time these short interbout feeding intervals commonly continue (Konner and Worthman, 1980). Evidence suggests that maternal gonadal function, apparently suppressed by a timing-dependent, prolactin-mediated effect of breast stimulation, may be a key variable in explaining the !Kung's lactation infertility.

Subsequent studies have demonstrated that night nursing has a role in the suppression of ovulation. Howie et al. (1982) investigated infant feeding practices associated with the most effective suppression of ovulation in a longitudinal study of twenty-seven mothers who chose to breastfeed their babies. Fourteen mothers suppressed ovulation throughout lactation and thirteen ovulated while still breastfeeding. Those who ovulated while breastfeeding had all introduced two or more supplementary feeds/day, reduced suckling frequency to less than six times/day and reduced suckling duration to less that 60 minutes/day at the time of first ovulation. Mothers who suppressed ovulation for more than 40 weeks post-partum breastfed for longest, suckled their infant most intensively, maintained night feeds for longest, and introduced supplementary feeds most gradually. The authors proposed that a long interval during the night without a suckling episode may enable the hypothalamic pituitary ovarian axis sufficient time to recover its normal function and resume ovulation (Howie et al., 1982). Studies have also demonstrated that prolactin release in response to night-time suckling is greater than during the day; thus milk production may get its greatest 'boost' when the baby feeds at night (Glasier et al., 1984).

Further studies have supported these findings, and the Lactational Amenorrhoea Method or LAM, has been formally recommended by the World Health Organisation and Family Health International as one of the most effective methods of fertility control (Moloney, 1998). Extensive studies by a group of international researchers investigating the effect of breastfeeding on the return of fertility concluded that a woman is more than 98% protected against pregnancy as long as she fulfils three criteria: that she is less than 6 months postpartum, has had no periods, and is fully or nearly fully breastfeeding (Family Health International, 1988). Ideally for maximum fertility suppression, it is recommended that there be no consistent interval greater than six hours between breastfeeds, and 80% of the baby's nourishment should come from the breast, with supplementation not exceeding 15% of all feeding episodes (Moloney, 1998).

Prolonged breastfeeding, bed-sharing and infant carrying observed among contemporary foraging societies, may have been an integral part of the regulation of the population size during our species' history. The birth of a child dramatically alters a mother's energy balance and lactation requires an additional expenditure of energy (Lozoff and Brittenham, 1979). Lozoff and Brittenham (1979) propose that in hunter-gatherer societies, a birth interval of three to four years allows each infant to complete the period of maximal need for the mother, without competition from younger siblings. During this time the infant has extensive body contact with the mother both day and night, and the care provided is highly responsive and consistently affectionate, nurturant and unrestrictive. By three to four years the child has achieved a degree of independence and autonomy sufficient to allow the mother to carry and care for a new infant (Lozoff and Brittenham, 1979).

Further support for this symbiotic relationship between bed-sharing and breastfeeding, and the potential effects frequent breastfeeding may have on maternal reproductive physiology, comes from studies of breastfeeding and sleep/wake behaviours among Caucasian La Leche League mother-infant pairs. In this group unrestricted breastfeeding is strongly advocated, a feeding behaviour more characteristic of women in developing societies than in Western society (Cable and Rothenberger, 1984; Elias et al., 1986).

Cable and Rothenberger (1984) reported that in a group of 24 La Leche League mothers, infants were fed on an average of 15 times per day over a 2 month period and mothers and babies frequently slept together, with 38% of pairs sleeping together on a nightly basis. Prolonged lactational amenorrhoea was also found, as 92% of the mothers nursing infants 5 to 16 months old has not regained their normal menstrual flow (Cable and Rothenberger, 1984). Of these 24 mothers, 22% relied on lactation alone as their method of contraception.

In a study investigating sleep/wake patterns of breastfed infants during the first two years of life, Elias and colleagues (1986) challenge the assumption that norms for sleep/wake patterns in infancy, developed in the 1950's and 1960's when breastfeeding rates in the West were at their lowest, are appropriate for breastfed infants. Published patterns for infant sleep/wake patterns during the first two years of life include an increase in length of maximum sleep bout from four to five to eight to ten hours by 4 months, but little decrease in total sleep in 24 hours from 13 to 15 hours (Kleitman and Engelmann, 1953; Parmelee et al., 1964; Coons and Guilleminault, 1982). Elias and colleagues (1986) followed thirty-two Caucasian, breastfed infants for two years and collected data on 24 hour patterns of breastfeeding and sleep: 16 families from La Leche League and 16 other families from the same communities. Infants who breastfed into their second year did not develop sleep/wake patterns in conformance with the norms (Elias et al., 1986). Instead of having long unbroken night sleep, they continued to sleep in short bouts with frequent wakings. Their total sleep in 24 hours was less that that of weaned infants. This pattern was most pronounced in infants who breastfed and shared a bed with the mother. Comparing infants in the La Leche League group to other breastfeeding infants, La Leche League babies were breastfed very frequently, weaned very late, and often shared a bed with their mother at night. In addition, infants from the standard care group, although conforming more closely with the published norms, still did not develop consistent eight to ten hour periods of unbroken sleep until the second year, when most had been weaned. The authors point out that sharing a bed and late weaning are common practices of many societies in the world. Night waking is not reported to be a problem in these cultures (Konner and Worthman, 1980; Elias et al., 1986), while in Western societies it has been called 'a disease of the developed world' (Bax, 1980, p. 1177). Elias et al. (1986) also consider it to be ironic that although night waking is much less frequent in infants cared for in the western style, it presents so much more of a problem for parents. The authors conclude that sleep/wake patterns presently considered the norm, may be attributed to early weaning and separated sleeping practised in western culture, and may need to be revised as prolonged breastfeeding becomes more popular in Western societies (Elias et al., 1986).

Summary

This detailed review of the literature has revealed several main points to consider when addressing the practice of bed-sharing. Bed-sharing or 'co-sleeping', together with breastfeeding and prolonged mother-infant contact, was the context in which infant sleep evolved. Physiological studies have demonstrated that infants experience measurable physiological consequences, many of them deleterious, when separated from their mothers for a prolonged period of time. Cross-cultural studies have shown that the majority of the world's population practise some form of mother-infant co-sleeping on the same bed or sleeping surface, and only Western industrialised societies consider it normal and desirable for an infant to sleep alone and through the night. Sharing a parent's bed has been associated with childhood sleep problems however a causal relationship has not been established. In some studies co-sleeping has been viewed as symptomatic of sleeping problems, when quite clearly the practice of co-sleeping was used by the parents as a last resort remedy in response to a child's behaviour. Studies of infants who sleep all night, every night with a parent from birth report fewer sleep difficulties. There is a strong association between bed-sharing and breastfeeding, with evidence to suggest that each practice promotes the other. The increase in risk of SIDS associated with bed-sharing has been found only to apply to infants of parents who smoke.

With the exception of recent groundbreaking work conducted by McKenna and colleagues in the last decade, investigations of infant sleep have been based on infants sleeping alone in 'solitary environments', the effects of which have not been assessed. Little is known about how parents care for their babies at night. Only recently have we begun to address the important effects of infant care practices with evidence-based, scientific research. Many questions remain to be answered with regard to the physiological and behavioural effects of night-time infant care provided by parents, including the practices of bed-sharing and room-sharing.

Part II

Methods

Chapter 4

The Study Design

Study Objectives

Previous studies of infant sleep have almost exclusively focused on infants sleeping alone, in isolation from their parents or caregivers (McKenna, 1996a). Little is known about how mothers care for their babies at night, although this is the period when most SIDS deaths occur. Certain behaviours such as bed-sharing appear to carry different risks depending on parental characteristics and the sleeping environment in which bed-sharing occurs (Fleming et al., 1996; Mitchell et al., 1997). It is not clear whether these variations arise from physiological and/or behavioural differences between different groups, or whether the practice of bed-sharing is a proxy marker for some other unidentified risk factor.

This study had three major objectives:

i) To investigate and document the nature and extent of night-time behavioural interactions between mothers and their babies during times of sleep.

ii) To quantify the behavioural differences between mothers and babies when they share the same environment and whether behavioural interactions are affected by immediate proximity i.e. bed-sharing in a double bed, as opposed to sharing a general environment i.e. room-sharing.

ii) To generate a standardised behavioural taxonomy for use in future studies investigating night-time infant care strategies, including bed-sharing and room-sharing practices.

Permission for this study was granted by the United Bristol Health Care Trust (UBHT) Research Ethics Committee.

Study Sample

Ten mother-infant pairs were recruited soon after the birth of their baby from the postnatal wards of Saint Michael's Hospital, a major regional maternity hospital, and from the surrounding communities of Bristol and Bath, England. All mother-infant pairs who volunteered for the study and met the inclusion criteria were asked to participate until the target of five mother-infant pairs for each of the study groups was obtained. Mother-infant pairs were allocated into one of two groups, depending on intended and actual (for those mothers already at home) sleep practice at the time of recruitment.

Inclusion Criteria

One group comprised five mother-infant pairs who routinely bed-shared. 'Routine Bed-Sharers' (RBS) were defined as mothers and infants who slept in the same bed (with or without the mother's partner) for at least 6 hours per night, 7 nights per week. The other study group was composed of five mother-infant pairs who routinely room-shared. 'Routine Room-Sharers' (RRS) were defined as mothers and infants who slept in the same room, however did not bed-share for more than 3 nights per week for any part of the night.

The ten mother-infant pairs who participated in this study met inclusion criteria for mothers and infants of low risk for SIDS (Brooks et al., 1992; Blair et al., 1996; Fleming et al., 1996). All the mothers in the study were Caucasian; were less than 40 years old; non-smoking; were exclusively or predominantly breastfeeding; had participated in prenatal care; were not taking any prescribed or self prescribed medications; had no history of alcohol or illicit drug use during pregnancy; had uncomplicated pregnancies, labours and deliveries; and were in good health and free of known sleep disorders. Mothers in both groups had chosen their sleeping practice for reasons other than infant temperament, and this was ensured by recruiting mothers within the first few days postpartum (8 mothers), and prior to delivery (2 mothers). This latter criterion was to eliminate infant temperament (e.g. response to an 'unsettled' or colicky infant) as a possible factor in choice of sleeping practice. Mothers were also chosen from one ethnic group to serve as a control for potential cultural differences in attitude toward, and the implementation of, bed-sharing.

Inclusion criteria for infants were that they were in good health with normal growth and development; born by spontaneous vertex delivery following pregnancies and deliveries free of medical complications; had been greater than 37 weeks gestation at delivery; were of appropriate weight for gestational age, birth weight >2500 grams; had a five minute

Apgar score ≥8; had no neonatal medical problems, and there was no familial history of sleep related disorders or SIDS in first degree family relatives.

Home sleep logs completed for seven days after each monthly visit to the laboratory confirmed the eligibility of each mother-infant pair to be included in their allocated group (Appendix A).

Process of Recruitment

Posters advertising for mothers who were willing to volunteer to participate in the study were placed in the corridors of the postnatal wards. The purpose of the project, including inclusion criteria for mother-infant pairs needed in the study, was explained to ward-based midwifery staff in informal ward meetings. Following liaison with postnatal ward staff members and a review of the medical notes which supported the eligibility of a mother-baby pair for inclusion in the study, mothers were approached by the researcher to participate. Mothers were informed that the study aimed to learn more about the interactions which occur between mothers and healthy babies during the night. Inclusion criteria were checked in a verbal interview with the mother on the ward, and for those mothers who were interested in participating in the study, both parents were invited to visit the laboratory with their baby prior to their discharge from hospital.

This visit provided the family with the opportunity to view the sleep bedroom environment and ask any further questions they may have had. Parents were provided with an information sheet (Appendix B) about the research project which provided a background to the study; what the research project would involve, and addressed safety and confidentiality issues. Parents were informed that they may withdraw from the study at any time if they so wished, without giving a reason and that it would not affect their future care in any way. The reverse side of this information sheet provided information regarding visits to the sleep laboratory. Families who consented to take part in the study were asked to complete a consent form (Appendix C).

Families who decided to participate in the study were asked to complete a questionnaire (Appendix D) and return this at their first overnight visit to the sleep laboratory. This data sheet included questions relating to the pregnancy and birth; the mother and infant's medical and sleep histories; the father's medical history; sibling sleep history if relevant; sleeping arrangements for the new baby; housing details; any familial history of SIDS, and several questions relating to their views about bed-sharing. The information obtained was used to confirm the eligibility for inclusion of each mother-infant pair in the study.

Six mother-infant pairs were recruited to participate in the study using the described process of recruitment. Five of these pairs were Routine Room-Sharers, and the sixth was a Routine Bed-Sharer.

Recruitment from the Community

Mother-infant pairs meeting the criteria for 'Routine Bed-Sharers', as opposed to 'occasional bed-sharers' as previously described (Lozoff et al., 1984; Heron, 1994), proved to be more difficult to recruit from the post-natal wards. During the period of recruitment the project and its aims received media coverage in the form of an article written by a journalist for 'The Independent' newspaper (Jackson in The Independent, 8-11-95), and through an article written for the National Childbirth Trust (NCT) newsletter by the author (Young, 1995). Both of these articles included a call for volunteers and the sleep laboratory subsequently received many phone calls from mothers who were willing to travel from all over England to participate in the study. Four mother-infant pairs meeting the inclusion criteria for Routine Bed-Sharers were recruited through mothers contacting the laboratory directly or through the National Childbirth Trust local branch network. After the initial contact was made with these four mother-infant pairs, the families visited the sleep laboratory prior to the first study. The same process of recruitment and confirmation of eligibility for inclusion was then followed, as previously described for the mother-infant pairs recruited from the postnatal wards.

Design of the Sleep Laboratory

The sleep laboratory resembled a comfortable domestic bedroom in size and furnishings, with a double bed and a crib positioned next to it. See Illustration 4.1. An infra-red light source, video camera and directional microphone were mounted on the wall opposite the bed and crib. The camera had zoom, pan and tilt facilities and was controlled from an adjacent laboratory where a member of the research team monitored the physiological, video and audio recordings throughout the night. The physiological signals were displayed and recorded on the personal computer and some of the signals together with the time signal were superimposed onto the video using a genloc card.

Within the room there was a private area with washing facilities, which was not visible to the camera, and a bathroom and kitchen were available close by for mothers to use. Infant changing facilities were provided in the bedroom. On a wall behind the bed, markers were placed 20 cm apart, to allow estimation of distances between mother and baby from the video recordings. Room temperature was maintained within a range of 18-22°C by an air conditioning unit (MSZ-09L, Mitsubishi Electric Corporation, Japan), which had the facility to be remotely controlled. Humidity was not directly controlled.

Physiological Monitoring of Infants

Physiological sensors were attached to the infants at a time determined by the mothers, which was usually during a feed. See Illustration 4.2.

Thermistors were taped to the mid-forehead, mid-shin and lower left abdominal quadrant (i.e. not over the liver) to measure skin temperature. Rectal temperature was measured with a thermistor on a flexible probe, inserted 5 cm into the rectum. Two other thermistors were attached, each insulated from the infant by 3 cm of foam: one to the outside of the infant's clothing at the level of the umbilicus, the other on the infant's head at the level of the vertex. These probes were used to measure the temperatures of the micro-environment around the infant's abdomen and head. The environmental room temperature was monitored by two black ball probes positioned close to the bed and the crib, and also by two thermistors placed by the walls. For several studies amongst the routine bed-sharers on bed-sharing nights, an additional thermistor was placed over the fontanelle and covered with 3 cm of foam and polystyrene insulation. Using the zero-flow principal this was an approximation of core cranial ('brain') temperature (Dollberg et al., 1993). Together with room humidity, all temperatures were recorded to a resolution of 0.05°C onto a data logger at 30 second intervals (Squirrel 1200, Grant Instruments, Cambridge).

Illustration 4.1 The Sebastian Diamond Mother and Baby Sleep Physiology Laboratory

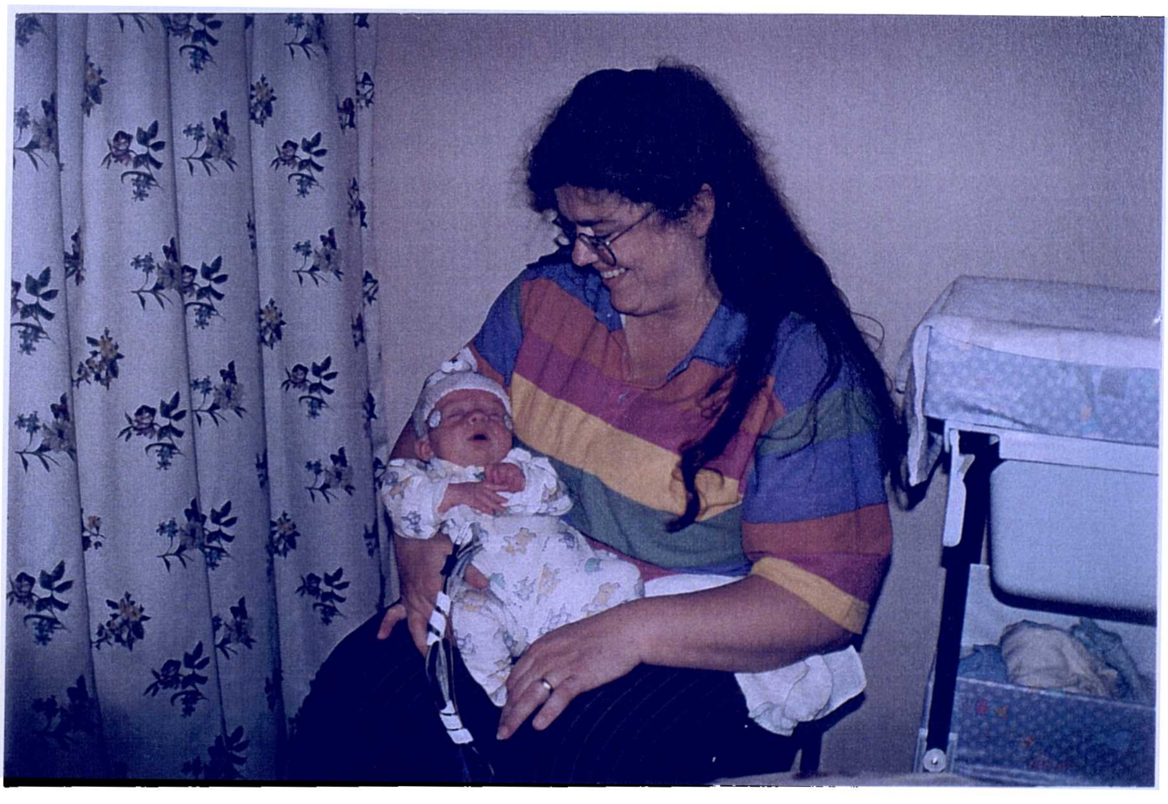
Illustration 4.2. Setting up physiological monitoring during a feed.

A single channel of electroencephalogram (EEG) [C3/A2 or C4/A1]; electroocculogram (EOG) [right upper and left lower outer canthus]; electrocardiogram (ECG); and chest and abdominal movements (resistance bands) were each digitally sampled at frequencies between 20-100 Hz. Oxygen saturation via a pulse oximeter was sampled at 1 Hz, and all signals were recorded onto a 90 Mhz Pentium personal computer, using an IMS 2000 polygraph (Pi Logic Ltd, Carmarthenshire, Wales) and CARDAS software (Oxcams Ltd, Oxford). Tidal CO_2 was sampled as an additional channel on the IMS 2000 at 20 Hz. A bi-lobed nasal oxygen prong (Salter Labs Ca, no 1611) was taped under the infant's nose, and air was drawn at 50 ml/minute into a CO_2 analyser (ELIZA Duo, Engstrom, Bromma, Sweden). If dislodged, the prong was usually replaced by the infant's mother, and for the majority of nights, near continuous recording was achieved. Recording accuracy for carbon dioxide concentration using this system was ±0.03%, and calibration, bacterial filter change, and cleaning of the tubing were performed periodically throughout the series of studies. Sampling of CO_2 was well tolerated in infants when they were less than 4 months old. As they grew older (at 4-5 months), some of the infants protested strongly during attempts to secure the nasal prongs. On these occasions if infants began to become distressed, the attempt to secure the nasal prongs was abandoned in order to maintain maternal cooperation with our studies.

All leads attached to the sensors were approximately 3 metres in length and were bound together to form a flexible 'umbilical cord' which emerged from the lower part of the infant's clothing. See Illustration 4.3. The length of this cord enabled complex recordings to take place during normal maternal care-giving such as breastfeeding, nappy changes, and cuddling. See Illustration 4.4. Mothers reported that because of the length of the 'umbilical cord' their mobility was not inhibited, and that they rapidly became comfortable in handling and caring for their infants whilst physiological recordings continued to take place. In order to facilitate normal behaviour and care of the baby by the mother, no monitoring leads were routinely attached to the mothers.

Illustration 4.3 The 3 metre 'umbilical cord'

Illustration 4.4 The length of the sensor cord allowed normal maternal caregiving



Observational Study with Crossover Design

This study was an observational study with a crossover design. Mother-baby pairs attended the laboratory for an initial study night when their baby was approximately four weeks old, and followed their usual sleep practice, which was either bed-sharing, or placing their baby to sleep in a cot beside the bed. The initial unpaired study night was regarded as an adaptation night to overcome 'first night effects' on laboratory sleep. Previous studies in adults and infants have shown that a period of adaptation resolves many of the initial effects to unknown environments (Agnew et al., 1966; McKenna and Mosko, 1994).

The study was also longitudinal in design as the majority of mother-infant pairs returned at monthly intervals until their baby was approximately five months of age. On each of these visits they were studied for two consecutive nights and were randomly allocated to either a Bed-sharing Night (BN) sharing a double bed, or to a Room-sharing Night (RN) with their baby sleeping in a cot beside the bed, on the first night, then vice versa on the second night. Each mother-infant pair therefore acted as their own control.

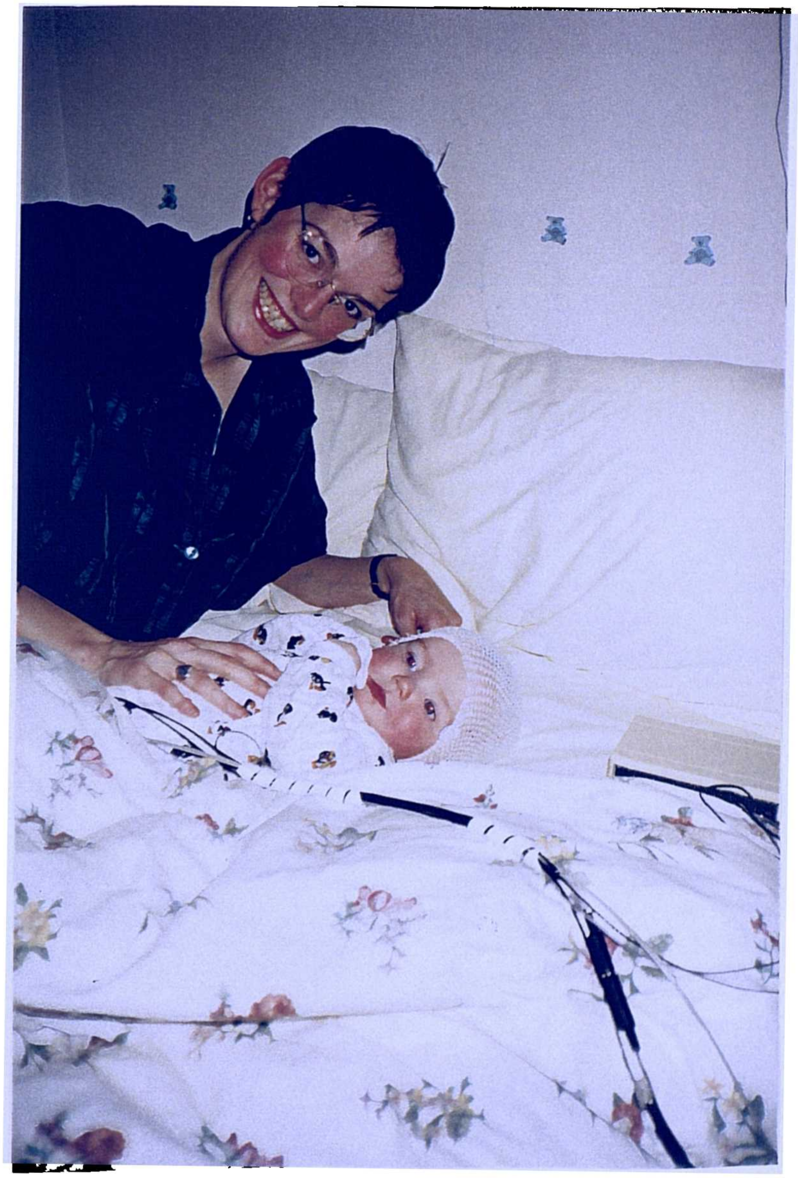
Overnight Recordings

Subjects arrived at the laboratory between 1900 and 2100 hours, depending on the baby's usual bed-time, and left between 0800 and 1000 hours the following morning. Mothers were free to choose the clothing and bedding they placed on their infant. Mothers were blind to all experimental hypotheses and were asked only to care for their babies as they would at home. Both members of the pair went to bed and rose at their usual times.

The researchers used a 'Study Log' to document activities for each night recording. This 'Study Log' (Appendix E) detailed information relating to commencement and completion times for video and physiological data; the channels of temperature recorded; baby clothing and bedding used; the times baby and mother fell asleep and awoke; and breastfeeding episodes. A detailed record of the night on a minute to minute basis could also be made together with any events of special note or technical problems that may have occurred.

Details of physiological recordings and results have been documented elsewhere (Sawczenko et al., 1995; 1997; Pollard et al., 1997). This thesis will address results from behavioural data obtained through analysis of video recordings which were made while ten mother-infant pairs either bed-shared or room-shared in the sleep laboratory over a period of five months.

Illustration 4.5 A mother and infant ready for an overnight sleep recording



Sampling Method, Sample Size, and Crossover Design

Sampling Method

The method employed in recruiting subjects for this study could be described as *purposive sampling* (Burns and Grove, 1993). Purposive sampling is sometimes referred to as judgemental sampling, and involves the conscious selection by the researcher of certain subjects or elements to be included in the study. This method of sampling allows the researcher to seek subjects with particular characteristics in order to increase theoretical understanding of some facet of the phenomenon being studied. In this case, mothers who were intending to share a bedroom with their baby were sought for the Routinely Room-Sharing group, and mothers who intended, or were already bed-sharing with their babies, were recruited into the Routinely Bed-Sharing group. This allowed an investigation of differences in behaviour and interactions between the two groups and between bed-sharing and room-sharing conditions.

There was however, an element of convenience involved with the sampling method used for the Routine Room-Sharing group. The Routine Room-Sharers were all recruited from post-natal wards of Saint Michael's Hospital, and therefore any mother-infant pairs who met the inclusion criteria and consented to participate in the study were recruited until the desired sample size of five mother-infant pairs was reached.

Purposive sampling has been criticised as a method of sampling as there is no way to evaluate the precision of the researcher's judgement (Burns and Grove, 1993). In this study, one could not determine whether the Routine Room-Sharers and Routine Bed-Sharers were typical of routine room-sharers and bed-sharers in the general population. However, strict definitions had been set with regard to who would be categorised as a Routine Bed-Sharer and Routine Room-Sharer, to avoid including pairs who occasionally bed-shared. Occasional bed-sharers have been identified as a group who often have very different reasons for bed-sharing, and sleep with their child reactively, rather than non-reactively, as a chosen or intended child care practice (Lozoff et al., 1984, Heron, 1994). Therefore purposive sampling was used to get some initial ideas about an area not easily examined using other sampling techniques (Burns and Grove, 1993).

Convenience sampling, used in recruiting the majority of Routine Room-Sharing mother-infant pairs, provides little opportunity to control for biases (Burns and Grove, 1993). Decisions related to sample selection need to be carefully described to allow others to evaluate the possibility of biases. The interviews with mothers prior to their inclusion in the study, the inclusion criteria, and the personal details questionnaires (Appendix D) completed by each participating family, provided the data needed to allow a thorough description of the sample. This information can be used to evaluate for possible biases and to compare the sample with other samples and for estimating the parameters of populations through meta-analyses (Burns and Grove, 1993).

The mothers who were willing to participate in this study were a particularly motivated group of mothers, predominantly middle class and well educated. Not only did these families agree to be involved in a study which meant having monitors attached to their baby for two nights each month for five months, but in fact the majority of the routine bed-sharers initiated contact with the researchers to become involved in the study. This study was therefore biased in two ways: i) mothers and infants were of low risk for SIDS, which was an objective of recruitment for the study; and ii) mothers were self-motivated to take part in the study, which cannot be controlled for, especially given the intrusive nature of the study and the level of commitment required to complete the five month study period. The results obtained should therefore not be generalised to populations other than middle class mothers and infants of low risk for SIDS.

Sample Size

The sample of mother-infant pairs recruited for the study was restricted to a total of ten, with five mother-infant pairs in each group. The plan during the design of this project was for this initial group of subjects to participate in a pilot study of night-time mother-baby behaviour and interactions. This restriction of numbers was partly due to staff time and resource limitations. These studies were labour intensive and prospectively studying a small group of mothers and babies would provide more information than a larger number studied cross-sectionally. For example, it was estimated that 10 mother-infant pairs studied for 9 nights over a 5 month period for 9-10 hours per night would generate 800-900 hours of recordings. Infant sleep staging analyses take approximately 3-4 hours per night of physiological recording (approximately 360 hours of analyses); and video analyses using the behavioural code take at least 6-8 hours to code an 8-12 hour video recording (approximately 540-720 hours of analyses). Together with computer data entry, data and reliability checking, and subsequent statistical analyses, it was evident that the proposed sample of 10 mother-infant pairs would generate an extremely substantial volume of work for 2 part-time researchers over a 12-18 month period.

Due to the relatively small sample size of the groups and the large number of variables within the groups, no formal matching of the mothers and babies was made. The longitudinal design of the study with the same volunteers attending the laboratory for overnight studies over a duration of five months provided the opportunity to build up a vast and unique database of physiological and behavioural data.

Mothers from all over England volunteered to participate in the study, however a restriction was placed on the sample with regard to geography. A high level of commitment and time was required to be sustained over a period of five months by families participating in the study, so action was taken by the author to limit the sample to mothers and infants living in the surrounding communities of Bristol and Bath. This was to avoid having volunteer mothers travel large distances with young infants to attend the consecutive night-time studies each month, which would have placed additional demands on their time and may have jeopardised their willingness to complete the study.

Mothers who volunteered for the study, but who were not recruited due to the large distances they would have to travel, were asked for their permission to be entered into a laboratory record of mothers who were interested in bed-sharing and room-sharing practices. These volunteers were the only mothers rejected from participation in the study on grounds other than the inclusion criteria. This record was kept to serve as a database of parents who would be interested in completing questionnaires about infant sleep practices, including bed-sharing, in the future.

The Crossover Design

This study was primarily an observational study investigating night-time behavioural interactions between mothers and their babies of low risk for SIDS. However the crossover design of the study enabled the effects of routine condition and experimental night condition to be examined in each of the two study groups. In crossover designs, the same group of subjects are given both (or all) treatments of interest in sequence. Comparisons are then made on the effects of the different treatments on the same subject (Altman, 1991). In this study, all mother-infant pairs underwent one night of room-sharing and bed-sharing each month.

The crossover design has some attractive features, in particular that the treatment comparison is 'within subject' rather than 'between subject' (Altman, 1991). In this study both 'within subject' and 'between subject' comparisons could be made as both RRS and RBS pairs underwent both treatment conditions. The crossover design also controls the variance in the study and allows the sample size to be smaller. The sample size required to detect a significant effect is less since the subjects act as their own controls (Altman, 1991; Burns and Grove, 1993).

Several difficulties may be encountered in relation to a two period crossover design. Crossover designs are particularly vulnerable to the effects of subject withdrawal. Subjects may drop out after the first treatment, and so not receive the second treatment. If a subject withdraws after the first period or treatment condition, they cannot be included in the analysis because they never received the other treatment. The randomised groups are compromised when there are withdrawals, especially when these are more common in one group. If there are many withdrawals it may be best to discard the data from the second period (Altman, 1991). Crossover studies should always document any withdrawals from the trial, with reasons, and the baseline characteristics of the two randomised groups should also be described (Altman, 1991).

Another difficulty with this type of study is that exposure to one treatment may result in *carry-over effects* that persist and influence responses of subjects to later treatments. In other words, the observed difference between the treatments will depend upon the order in which they were received. In the presence of such a 'treatment-period interaction' the data for the second period may have to be discarded, severely weakening the trial (Altman, 1991). These carry-over effects may include *practice effects*, in which subjects improve as they become more familiar with the experimental protocol, or *fatigue effects*, in which they may become tired or bored with the study. Crossover or counterbalancing, is a design strategy to guard against possible erroneous conclusions resulting from carry-over effects. Using the crossover design, subjects are randomly assigned to a specific sequencing of treatment conditions. This distributes the carry-over effects equally across all conditions of the study, to minimise the bias (Burns and Grove, 1993). Each month, and therefore at each age point, on the first of the two consecutive nights that they visited the sleep laboratory, subjects in this study were randomly assigned to either bed-share or room-share on the first night, and then vice versa on the second night, minimising the bias of any practice or fatigue effects which may have occurred. In this study, random assignment was achieved by having subjects draw one of the two options from a sealed envelope on their arrival at the laboratory.

In the crossover design there may be some systematic difference between the two periods of the trial. For example, the observations in the second period may be somewhat lower than those in the first period, regardless of treatment (Altman, 1991). A small *period effect* is not too serious, as it applies equally to both treatments. To prevent an effect related to time, the same amount of time needs to be allotted to each treatment, and the crossover point needs to be related to time, not to the condition of the subject. In this study, the overnight studies for both bed-sharing and room-sharing nights were similar in duration. The day long break between night 1 and night 2 (approximately 12-14 hours) also served as a 'washout period' between treatments to dissipate the effects of the first night condition (Altman, 1991; Burns and Grove, 1993). Crossover or counterbalancing is only effective if the carry-over effect is essentially the same from treatment A to treatment B as it is from treatment B to treatment A. If one is more fatiguing than the other or more likely to modify response to the second treatment, counterbalancing will not be effective (Burns and Grove, 1993).

The home sleep logs completed by mothers indicated that the sleep behaviours we observed in the laboratory on their routine night were very similar to sleep experienced at home.

Chapter 5

Analytical Design

Main hypotheses to be tested

This study was primarily an observational study investigating night-time behavioural interactions between mothers and their babies of low risk for SIDS. However the crossover design of the study enabled the effects of routine condition and night condition to be assessed. The null hypothesis proposed for this study was therefore:

The nature of night-time behavioural interactions which occur between mothers and their babies of low risk for SIDS is not affected by the environment in which they sleep, i.e. bed-sharing versus room-sharing.

The main hypotheses to be tested in this study were grouped into nine main areas. The specific variables associated with each of these areas requiring investigation are listed below:

(a) Maternal and infant sleep/wake states:

i) the effects of bed-sharing and room-sharing on infant sleep/wake states;

ii) the effects of bed-sharing and room-sharing on maternal sleep/wake states;

iii) the effects of bed-sharing and room-sharing on concordance of sleep states between mother-baby pairs.

(b) Maternal and infant movements and noises:

i) the effects of bed-sharing and room-sharing on frequency and duration of infant movements and noises;

ii) the effects of bed-sharing and room-sharing on frequency and duration of maternal movements and noises.

(c) Interactions between mother-infant pairs

i) the effects of bed-sharing and room-sharing on the frequency of night-time interactions occurring between mothers and infants;

ii) the effects of bed-sharing and room-sharing on the frequency of night-time interactions initiated by baby;

iii) the effects of bed-sharing and room-sharing on the frequency of night-time interactions initiated by mother;

iv) the effects of bed-sharing and room-sharing on the frequency of night-time interactions which occur simultaneously between mothers and their infants;

v) the effects of bed-sharing and room-sharing on the time taken for infants to respond to a mother-initiated interaction;

vi) the effects of bed-sharing and room-sharing on the time taken for mothers to respond to a baby-initiated interaction.

(d) Breastfeeding

i) the effects of bed-sharing and room-sharing on the frequency of night-time breastfeeding episodes;

ii) the effects of bed-sharing and room-sharing on the duration of night-time breastfeeding episodes;

iii) the effects of bed-sharing and room-sharing on the total time spent breastfeeding during the night.

(e) Infant sleep position

i) the effects of bed-sharing and room-sharing on the time spent during the night in the supine position;

ii) the effects of bed-sharing and room-sharing on the time spent during the night in the prone position;

ii) the effects of bed-sharing and room-sharing on the time spent during the night in the side-lying position.

(f) Proximity between mother-infant pairs:

i) the effects of bed-sharing and room-sharing on mother-infant proximity during the night.

(g) Maternal and infant body orientation:

i) the effects of bed-sharing and room-sharing on the time mothers and infants spend in body orientations which face each other during the night.

(h) Physical contact between mother-infant pairs:

i) the effects of bed-sharing and room-sharing on the time spent during the night in which mothers and infants are in physical contact.

(i) Bedding arrangements for infants and mothers:

i) the effects of bed-sharing and room-sharing on the type of bedding chosen by mothers for maternal and infant use;

ii) the effects of bed-sharing and room-sharing on the number of layers of bedding chosen by mothers for maternal and infant use;

iii) the effects of bed-sharing and room-sharing on the level at which bedding was positioned on the baby's body by the mother;

iv) the effects of bed-sharing and room-sharing on the level at which bedding was positioned by mothers on themselves.

Many of these hypotheses were based on *a priori* knowledge from several previous studies. Given the lack of direct knowledge of how parents care for their babies at night, or how these actions affect normal infant physiology and behaviour, certain questions needed to be answered. What is bed-sharing in a Western Caucasian population of low SIDS risk? Are Caucasian mothers who are routinely bed-sharing, different from mothers who are not. If so, how are they different? Do mothers and infants interact during the night? If so, who initiates these interactions and how are they initiated? Does bed-sharing alter infant physiology or the interactions that take place? Would a study of bed-sharing practices in a Western Caucasian population of low SIDS risk reveal similar findings to those reported by other populations, such as Latino mothers, in which bed-sharing is the cultural norm? (Mosko et al., 1996; 1997a; 1997b; Richard et al., 1996; McKenna et al., 1997)

The Pacific Islanders, reported in the New Zealand Cot Death Study to have the highest rates of bed-sharing and the lowest rates of SIDS, were noted to place their infants *on*, rather than *in*, the parental bed (Tuohy et al., 1993). Prone sleeping has been identified as a significant risk factor for SIDS in almost all the studies in which it has been investigated (Gilbert, 1994) and side sleeping has also been shown to be an independent risk factor (Fleming et al., 1996; Mitchell et al., 1997). Heavy wrapping, soft bedding, general clothing and textile practices including the use of duvets and cot quilts, have all been identified as risk factors for SIDS (Fleming et al., 1990; Ponsonby et al., 1993; Kemp et al., 1994; 1998; Wilson et al., 1994; Williams et al., 1996). Infant sleep position, infant location, and bedding arrangements used when bed-sharing and room-sharing in a population of low SIDS risk therefore warranted examination, and the following questions were proposed: Where and how does a mother place her baby to sleep when bed-sharing or solitary sleeping? Does the baby sleep in the bed or on the bedcovers when bed-sharing? Where do they end up? What bedding is used and how is it arranged?

The analysis of behaviours in this study of mothers and infants of low risk for SIDS while they room-share and bed-share forms a basis on which to understand high risk groups, and may potentially identify specific behaviours that may be associated with an increased risk of SIDS.

<u>The Behavioural Code</u>

Measuring behavioural night-time practice of mothers, infants and the interaction between them is a relatively new concept in this research area. Based on pioneering anthropological work conducted by McKenna and colleagues in the United States, one of the aims of this study was to adapt previous behavioural codes and generate a standardised measurement for specific use in investigations which aim to describe and document night-time infant care strategies, including room-sharing and bed-sharing practices. The behavioural code used in this study is described here, and detailed shorthand codes which were used are documented in Appendix F. The methodology used in designing the behavioural code was based on adaptations of ethological observation techniques. The ethological theory and approach to human behaviour upon which the scientific method of observation in this study was based, is discussed in Chapter 6. A standardised behavioural taxonomy proposed for use in future investigations is described in Chapter 9, and will be discussed later.

Video recordings of mother-infant pairs were hand-scored and manually documented onto a log sheet in real time using a behavioural coding system which reviewed data in 30 second time intervals. This time period was selected to allow for matching of the behavioural interactions with physiological and temperature recordings, which were also recorded and stored in 30 second time periods.

Variables of behavioural data for each night's video recording were then entered into an EXCEL 5 spreadsheet on the computer. These manually coded logs of sleep behaviour served as a hard copy of the video data as well as a method of checking accuracy of the data entered onto the EXCEL database. If video data had been erroneously coded directly from video to computer, there would have been no way of checking accuracy unless the video was reviewed again. A shorthand code was developed to describe movements, noises and events which occurred repetitively (See Appendix F).

The times at which mothers and their babies settled to sleep varied greatly, so a comparable period of the night when the majority of mothers and babies had settled for their night's sleep was identified. Using infant sleep state as a reference point, the author has focused on a five hour period between 0100 and 0700 hours, commencing with the first minute of active, or rapid eye movement (REM) sleep, at or after 0100 hours. Results of mother-infant behaviour from this period of the night will be presented following a description of the behavioural code developed for the purpose of video analysis.

Frequency and Duration of Movements and Noises

Each movement and noise made by both mothers and infants was timed and recorded. Real time start and stop times, and the duration of the movement and/or noise (in seconds) was entered into the EXCEL spreadsheet. An 'x' was entered into the columns adjacent to the duration of the movement/noise to indicate whether the event was a movement or noise, or a combination of both. A description of what the movement, noise or interaction involved was also included in an additional column. Movements and noises occurring close together were considered to be separate, discrete events if at least 3 seconds separated the cessation of one and the beginning of another.

Interactions

For each movement and/or noise which resulted in a response from the other member of the pair, the initiator of the interaction (baby or mother), and the time it took for the other member of the pair to respond - the 'delay time' (in seconds), were documented, together with a description of what occurred during the interaction. Equally initiated or 'simultaneous' interactions were defined as interactions occurring between mother-infant pairs within the same one second time period, with a delay time of less than one second.

Breastfeeding Analysis

Breastfeeds were recorded in the interaction section of the behavioural code. Four breastfeeding variables were computed for each night: frequency, duration, mean duration and total feeding time of breastfeeding episodes. Breastfeeding behaviour was quantified using an adaptation of the breastfeeding criteria previously described by McKenna and colleagues (1997), with the additional criteria that a breastfeed was considered a separate episode when it commenced more than three minutes after the cessation of a previous episode. Breastfeeding was defined as nipple attachment, which was usually verifiable through observation of the video recordings. Chin electromyograms were not recorded in this study and therefore identification of breastfeeding did not rely on infant sucking behaviour. On a very few occasions the infant's head was obscured by blankets for part of the feed, and sleep physiology records were used to determine whether the feed continued or had finished, or if the infant had returned to sleep.

McKenna and colleagues (1997) quantified breastfeeding behaviour as breastfeeding episodes. Breastfeeding episodes began and ended with nipple attachment and detachment respectively, but also included very short interruptions during which the mother changed from one breast to the other. These interruptions were usually a matter of seconds and within the 30 second time period. All breastfeeding episodes were initiated by the mother placing her nipple in her infant's mouth and defined to capture a single, intentional and continuous act of breastfeeding on the mother's part. A new breastfeeding episode was scored if breastfeeding was interrupted by maternal behaviours that indicated an apparent attempt by the mother to terminate feeding (i.e. closing her bra or nightgown, or attempting to reposition to return to sleep), but the infant's subsequent refusal to settle prompted the mother to reinitiate feeding, and the new episode commenced at least three minutes after the cessation of the previous episode.

To determine the number of feeds during the period of sleep, the last feed before the infant went to sleep, and the first feed in the morning after the infant was considered awake for the day, were not counted in the total number of breastfeeding episodes. The majority of night feeds occurred in the 5 hour period of video analysis. For those breastfeeds which met the criteria for inclusion, but occurred outside of the 5 hour period of video analysis, video data for each night were scanned to find start/stop times and duration for these feeds.

Proximity

The code grouped the head and body distances between mother and baby into three bins which were in multiples of 20 cm: i) less than 20 cm; ii) 20-60 cm; iii) greater than 60 cm. The measurement of 20 cm bins was chosen as a four week old infant's arm was measured to be approximately 20 cm in length, and a female adult, of average height and build, has an arm length of approximately 60 cm in length. These bins therefore represent i) < 20 cm: within a baby's arm reach; ii) 20-60 cm: within a mother's arm reach; and iii) > 60 cm: beyond a mother's arm reach.

Distances between mothers and infants were measured using the markers which were visible on the wall behind the bed, placed 20 cm apart. Proximity of the pairs' heads or faces was derived by measuring the distance on the video screen between the pair's nares and computing the actual distance using the markers which were visible in the video field. The same technique was used to determine the proximity of the pair's bodies, this time using the distance between the pair's trunk or limbs (whichever was closest to the other member of the pair), as reference points. Head to head distances and body to body distances for mothers and infants were scored separately.

Body Position

The method of analysing video recordings of mother-infant pairs also provided information relating to the amount of time infants and mothers spent during the night in each of the three body positions: i) supine; ii) prone and iii) side-lying positions.

Physical Orientation

Physical orientation was described in terms of head and body positioning in relation to the other member of the pair, and whether or not a member of the pair was facing toward their partner. Maternal and infant body positions were described first, followed by a code for the orientation of the face. These body positions included supine, prone and side-lying positions. Lateral or 'side-lying' positions were described in terms of whether or not the ventral surface of one member of the pair was facing their partner.

'Facing towards' orientations were considered to be when the face ± the ventral surface of the trunk of one partner was orientated towards the other member of the pair. This included both supine and side-lying positions in which faces were orientated towards their partners. 'Facing away' orientations were considered to be when the face ± the ventral surface of the trunk of one partner was directed away from the other member of the pair. Body orientations were considered neutral when mother or infant were not facing towards or away from their partner. These positions included the supine position in which the face was orientated upwards, and the prone position in which the face was orientated straight down. (See Appendix F for examples).

Physical Contact

The amount of time that mothers and infants spent in physical contact during the night was recorded and described in relation to which parts of the mother's and infant's body were touching. The initiator of the tactile contact was also recorded as to whether it was baby or mother initiated. When there was an equal contribution by both mother and infant to contact that was made, e.g. breast feeds in which the baby is actively feeding and the mother offered her breast and was holding or cuddling the infant, the initiator of the contact was described as being equal, or simultaneous. (See Appendix F for examples).

When bed-sharing, physical contact which occurred between the pair was occasionally obscured by bedding for short periods. On these occasions contact was coded only after consideration of the following criteria: a) there had been prior physical contact and i) body positions remained the same, and ii) head and body distances remained the same or less. b) Proximity of head and/or body was less than 20 cm between the pair; and body position and orientations faced towards each other with/without arms extended toward the other member of the pair (When head distance between mother and baby was less than 20 cm apart and both members of the pair were supine or side-lying it was considered very unlikely that no contact under the covers occurred); c) Bedding position and shape around the mother and baby indicated that touch or pressure was being exerted either through or under the bedding. This included contact which was made when mothers positioned their arms over the bedding and across their infant's body. After each movement of mother or baby the coding for any physical contact which was observed was re-evaluated using the above criteria.

Bedding

The behavioural code described the type of bedding chosen and the level to which it was placed and ended up, on the body of the infant and the mother. Categories of bedding included a) a standard 10 tog duvet; b) single layer sheet; c) cellular blankets. The number of layers of cellular blankets which mothers chose to place on their infants were described as i) 1 air cell; ii) 2 air cells; iii) 3 air cells; iv) 4 or more air cells. Positions of bedding on the body were categorised into six levels, in which bedding covered i) trunk to shoulder level (neck) with both arms covered by bedding; ii) trunk to shoulder level with one or both arms uncovered; iii) trunk to midchest (epigastric) level; iv) trunk to level of the hips; v) body completely uncovered by bedding; vi) head and body completely covered by bedding. The periods of time in which mothers left their bed or room, and were therefore completely uncovered by bedding, e.g. to change the baby's nappy or clothing, or to visit the bathroom, were removed from the bedding analysis to determine more accurately maternal behaviour with regard to bedding use whilst the mother was in bed.

Information on maternal and infant bedding and clothing was used to calculate the total thermal resistance using published values for the thermal resistance of each material (Clulow, 1987). These values were expressed in tog units (the tog value of a fabric is defined as 10 times the temperature difference in degrees Celsius between its two faces when the heat flow is equal to 1 W/m^2). The proportion of maternal and infant body or surface area covered by each garment or item of bedding was estimated, and these values were used to calculate an effective total thermal resistance for the coverings on each infant and mother. The estimates of surface area covered by each garment were based on data produced by the International Standards Organisation (International Standards Organisation Working Group, 1986) for adult clothing modified by factors relating to proportional surface areas of body parts in infants and adults, as documented previously (Boyd, 1935; Clulow, 1987; Fleming et al., 1990). Swaddling was assumed to increase the effective thermal resistance of the swaddling bedding by a factor of two (Fleming et al., 1990). The data on thermal resistance of bedding and clothing and on proportional covering by various garments were supplied by the Shirley Institute, Manchester (Clulow, 1987).

Sleep Staging

Maternal sleep states were based on observations of the mother in which each minute of the recording was categorised as to whether the mother was awake or asleep. Awake periods were defined when the mother's eyes were open for at least five seconds. These periods were usually accompanied by sustained gross body movements, irregular breathing and vocalisation directed towards the infant. Asleep periods were defined when the mother's eyes were closed for at least five seconds, and were usually accompanied by regular breathing, and occasionally snoring. There was an absence of gross body movement, however the presence of twitches and brief head movements were permitted. Where the observer was not certain of sleep/wake state, the period was categorised as 'appears awake', ' appears asleep' or rarely, as 'state not known'.

Similar observations were made for the staging of infant sleep, however these observations were then replaced with infant sleep states deduced from analysis of the overnight polysomnograms recorded from the infants. Infant sleep staging was performed off line by review of each minute using the EEG, EOG, respiratory, ECG and video channels in a modification of the methods of Anders et al. (1971) and Stefanski et al. (1984), which has been previously described by Azaz and colleagues (1992). This system uses the phase relationship between ribcage and abdominal signals as a marker of intercostal muscle tone, to help distinguish quiet from active sleep. Changes in sleep state were scored if they lasted 2 minutes or more, and arousals of more than two minutes were recorded as awake periods. Periods of indeterminate sleep state generally occurred at the boundary between active and quiet sleep, although there were a few longer periods in younger infants that were not classifiable and thus also recorded as indeterminate for the purposes of analysis. For consistency and due to the wide age range of studies (from one to five months of age), only active and quiet sleep were categorised with no sub-division of quiet sleep, as this cannot be reliably performed in infants of 2 months or less. See Appendix G for a description of the criteria used in infant sleep staging.

Comments

A column of the behavioural code was allocated to comments. This section allowed thumb and finger sucking behaviours, dummy use, and video tape changes to be documented, and mother-baby interactions, bedding arrangements, and unusual occurrences to be described in more detail. Details of events which did not fall into the specific categories in the code were documented in the comments section in relation to when and how they occurred.

Reliability Checking

The majority of the video recordings were coded by the author. However, due to time constraints, a second individual was employed to assist with behavioural coding of the video data and subsequent analysis. A convergence design was used in checking the uniformity of coding by both individuals. Initially, several studies were coded by both individuals together, to familiarise the assistant with the behavioural code and method of documentation. The assistant then coded several studies alone, one of which had already been coded by the author. The author and assistant met again to discuss the coding, any problems and any discrepancies which had occurred. Discrepancies were rechecked and mutually agreed upon after re-examination of the original video data. Regular meetings were held between the researcher and the assistant throughout the period of video data analysis to discuss any queries that arose with regard to the behavioural coding; especially coding of unusual events.

Intra- and inter-observer reliability checking was performed at the end of the period of coding to determine the degree of consistency within, and between, the individuals using the behavioural code. Reliability checking was performed on eight randomly selected, overnight recordings; four of which were coded by the author and four by the assistant. Each coder watched and recoded a two hour section from four studies, two of which she had originally coded (one at the beginning, and one at the end, of the period of behavioural coding), and two of which the other coder had done (again, one at the beginning, and one at the end). The recoded sections were compared with the original coding in order to check intra- and inter-observer reliability.

With each study, the original and recoded versions of the data were entered into an EXCEL spreadsheet or SPSS data file. T Tests and one way ANOVA tests were used to identify significant and/or consistent differences between original and recoded sections. See Appendix H for a detailed reliability checking report.

Statistical Techniques

In this study, observations from several nights were obtained for each mother-infant pair in the sample and then these multiple observations were pooled to create a data set consisting of samples of behaviour. The majority of statistical tests employed in research analyses assume that the elements in a data set represent a random sample of individuals from the population, and that the elements are independent of each other. When this is not true, the validity of inferences based on such tests may be jeopardised (Machlis et al., 1985). To take into account the repeated measures both inherent in the crossover design and the different ages of mother-infant observations, complex statistical tests would have to be utilised. These tests include a linear mixed effects model, that takes into account variation on at least three levels (variation in infant age, variation in crossover design, and variation in the observations made) and mathematical models of cubic polynomials. Given the small sample size and the observational nature of a study that is investigating interactions which have not been previously explored, the statistical analyses will be limited to a more simple, descriptive nature. Where statistical tests have been performed, the repeated measures have been treated as independent data points. The bias this could introduce is discussed in Chapter 8. In the analyses for this study, to provide a more cautious interpretation of the findings, a lower significance level of 1% has been assumed.

Given the small numbers in this study no assumptions were made about normal distribution of data; non-parametric methods of analyses were therefore used. Medians, interquartile, and in some cases, full ranges, were used to describe the midpoint and variation of each distribution. Within-group comparisons of the bed-sharing nights and room-sharing nights for both groups were performed using the Wilcoxon matched pairs signed rank sum test for each of the variables examined. The Mann Whitney U test was used for between group (RBS versus RRS) comparisons. ANOVA tests were also used to detect age related trends. The analysis was conducted using EXCEL 5 and SPSS 6.1 computer packages.

Analyses of maternal and infant sleep/wake states

For the purpose of maternal sleep/wake state analyses, periods of 'awake' and 'appeared awake' coded from video behavioural data were categorised as awake periods, and periods of 'asleep' and 'appeared asleep' were categorised as asleep periods. Periods coded as 'state not known' were excluded from the analyses. Infant sleep state was determined from physiological recordings.

Concordance between sleep states has been defined, for the purpose of this investigation, as i) the percentage of time in which the baby was in a defined state, that the mother was in the same or similar state; and ii) the percentage of time in which the mother was in a defined state, that the baby was in the same or similar state. Predicted concordance was the random association which would be expected for the period of the night in which there was concordance between mother and infant sleep/wake states. For example, the random association between a mother who was awake when her baby was awake was calculated by multiplying the period or percentage of the night the mother was awake with the period the baby was awake, e.g. 29% (mother awake) x 10% (baby awake) = 2.9% (predicted concordance). Similar calculations were performed for i) when mother was awake when her baby was in rapid eye movement sleep (REM); ii) when baby was in REM when his/her mother was awake; and iii) when mother was asleep when her baby was in Quiet sleep.

Analyses of variables by age

The longitudinal design of the study allowed age related trends in the data to be examined. Most mother-infant pairs behaved consistently over time, with more variation between mother-infant pairs than between age groups. Graphically there appeared to be few age related trends in the data, most of them not significant in ANOVA analysis. Variables from the different infant ages were therefore grouped together when analysing the behavioural data.

Chapter 6

Application of Ethological Techniques to Human Behaviour

Human behaviour has been the primary focus of many disciplines including psychology, psychiatry, ethology, anthropology, sociology, theology, economics and political science. Many of the methods used to observe, explain and predict a wide variety of phenomena involving the behaviour of human beings are common to these scientific disciplines and include the observation and recording of behaviour with or without experimental intervention (Heimstra and Ellingstad, 1972; Sheridan, 1979; McConnell, 1986). The methodology used in designing the behavioural code, detailed in the Chapter 5, was based on adaptations of ethological observation techniques. This chapter will provide a summary of the contributions made by the discipline of ethology to the study of human behaviour; the advantages and limitations of the ethological approach; the suitability of ethological methods for use in this study; and how these sampling methods were successfully adapted and incorporated as scientific methods of observation in this investigation of night-time behaviour and interactions between mothers and their babies.

Ethology

Many definitions of what constitutes 'ethology' have been offered in the literature, although a precise and widely accepted definition eludes ethologists (Lehner, 1996). According to two of its most prominent founders, Konrad Lorenz and Nikolaas Tinbergen, the field of ethology can be defined as

> 'the biology of behaviour' (Eibl-Eibesfeldt, 1975, p. 9).

Ethology has also been variously described as the comparative study of behaviour, the study of social behaviour of animals, and the study of animal behaviour in its native setting. Together, these definitions roughly encompass a modern version of this field of enquiry (White, 1974). The essential orientation of ethology is to the relationship between organisms and their environments (White, 1974; Lehner, 1996). Ethology developed out of zoology and emerged as another discipline exploring the research areas of behaviour and the phenomena of learning in the natural sciences (Eibl-Eibesfeldt, 1975). It places emphasis on the notion that the behaviour of animals and its physiological basis has evolved phylogenetically and should be studied as one aspect of evolution (Cranach et al., 1979). The realisation that phylogenetic adaptations determine the behaviour of animals in a definable manner has increasingly led those sciences which deal exclusively with humans to search for biological bases of human behaviour.

Human Ethology

The way human beings behave has been the subject of intensive study by sociologists, anthropologists, psychiatrists, psychologists, political theorists and military tacticians (Huntingford, 1984). Given the existence of specialist disciplines devoted entirely to the subject, there has been much debate about whether ethology could add anything to what was already known about human behaviour (Cranach et al., 1979; Hinde, 1982; Huntingford, 1984). The concept of 'Human Ethology' is relatively recent, and only twenty years ago whether it may rightly be called a new discipline was still controversial (Eibl-Eibesfeldt, 1975; Cranach et al., 1979; Hinde, 1982). Issues raised for discussion included whether it was logical to make inferences from animal to human behaviour; whether culture and history provided the same conditions for the development and determination of human behaviour as does the natural environment for animal behaviour; and whether typically human forms of behaviour exist which cannot be dealt with adequately in terms of (animal) ethology?' (Cranach et al., 1979).

Cranach et al. (1979) described two ways in which ethology has contributed to the understanding of the ontogeny of behaviour in humans. These contributions have resulted from 1) the application of techniques for the precise observation, description and classification of naturally occurring behaviour; and 2) from the ethological approach to the study of behaviour, especially the development of behaviour in terms of evolution. Of particular interest to the ethologist are questions relating to the function of a particular kind of behaviour, e.g. attachment behaviour and its adaptive value. The description of the behavioural repertoire of a species, the recognition of patterns of behavioural development, and the classification of established behavioural patterns are prerequisites for any comparison between different species or between organisms of a single species. The ethological approach is to study the interaction between the organism with certain innate species-specific structures and the environment for which the organism is genetically programmed (Cranach et al., 1979). In trying to understand why an animal or human behaves the way they do, ethologists search for the functions of the observed behaviour patterns in order to learn what selection pressures have shaped their evolution (Eibl-Eibesfeldt, 1975).

Eibl-Eibesfeldt (1975) wrote the first extensive review of the evidence for the relevance to human behaviour of such classical ethological ideas as fixed action patterns and releasing mechanisms. Much of human ethology as presented by Eibl-Eibesfeldt and other ethologists is concerned with showing that human behaviour has genetic (innate) components independent of, or interacting with, acquired (cultural) aspects of behaviour (Burghardt, 1973). Many studies by ethologists have been conducted with human infants, who have less experience and fewer opportunities to learn than adults, to determine what fixed action patterns and sign stimuli or releasers are present that are similar to those seen in other animals, where the question of their being innate is less controversial (Burghardt, 1973). Ethological observation studies have provided data on newborn behaviours including grasp, sucking and rooting reflexes; smiling and crying behaviours; and coordinated climbing, walking, swimming, and crawling behaviours in newborn infants. These studies support the view that humans have a number of innate behaviours at birth which resemble responses seen in young organisms of many species, and which therefore have an evolutionary basis (Burghardt, 1973).

<u>The Ethological Approach</u>

Tinbergen has argued that the most important application of ethology to humans lies with ethological methods, rather than with specific theoretical constructs (Tinbergen, 1968 cited by Burghardt, 1973). Burghardt (1973) has since emphasised the importance of acknowledging that ethological methods can be utilised without ascribing to ethological concepts or theories.

> 'Ethology...is characterised by an observable phenomenon (behaviour, or movement), and by a type of approach, a method of study (the biological method)...The biological method is characterised by the general scientific method' (Tingbergen, 1963 cited by Lehner, 1996, p. 11).

Philip Lehner (1996) describes how the ethological approach is the result of fitting the scientific method to ethology. It consists of a stepwise procedure by which data are gathered and analysed using descriptive statistics (descriptive research) or test statistics in order to test hypotheses (experimental research). The ethological approach expands on four basic operations: 1) the isolation of objects or variables to be measured; 2) the establishment and definition of units of measurement; 3) the comparison of actual events and units; and 4) the interpretation of the meaning of the observed events (Lehner, 1996).

The methodological core of ethology is based on detailed observation of behaviour either in the field or in the laboratory. After description of the repertoire of species-characteristic behaviours (the ethogram), the ethologist is interested in studying the function, the adaptive value both to the individual and the species; the causation, both internal and external; the ontogeny, from prenatal development to conditioning in adults; and the evolution of behaviours. Social behaviour has been the focus of much of the ethologist's attention. Laboratory and experimental studies are seen as important primarily as they help to elucidate behaviour in the field (Burghardt, 1973).

The ethological approach differs from more conventional techniques for studying human behaviour in that it is non-intrusive, involving more observation rather than experiments, questionnaires or interviews. In addition, the categories of behaviour selected for analysis are individual movement patterns, for example 'bite' and 'touch', rather than global, interpretative concepts, such as hostility and affiliation. The relationships between these items of behaviour are then investigated by studying their correlations and sequential relationships (Huntingford, 1984). The descriptive techniques used by ethologists are now employed by a number of disciplines, including social psychology, developmental psychology, anthropology, and psychiatry (Hinde, 1982).

Burghardt (1973) describes how observational studies can be classified into five categories, however that there is often considerable overlap between these categories: 1) studies which describe as completely as possible most of the behaviour of a person or group in pursuing their normal activities; in an attempt to construct an ethogram; 2) studies which narrow down the ethogram to one particular setting, such as the school or home; 3) studies which consider functional groupings of behaviour such as courtship, aggression, or maternal care; 4) studies which examine elements common to many behaviours, such as facial expressions, grouping patterns, or problem solving; and 5) studies which investigate the fine grain of behaviour or perception based on an extremely detailed analysis (Burghardt, 1973). The investigation in this thesis is a combination of the first three of these categories, as a primary aim of the behavioural code was to describe as completely as possible the night-time behaviour and interactions between mothers and their infants during times of sleep, and therefore included night-time maternal care of infants. The ethogram in this study may be described as a restricted setting ethogram as mothers and infants were observed as they slept in one location, a sleep laboratory which resembled a domestic bedroom, which facilitated unobtrusive recording of night-time mother-infant behaviour (Burghardt, 1973).

Ethological approaches to understanding human behaviour were first used to study young children, primarily because language is less important in the social relationships of young children than it is for older children and adults (Huntingford, 1984). Two landmarks in the growth of the close relationship which has grown up between ethology and some students of child development have been John Bowlby's use of ethological concepts in his theories regarding the mother-child relationship and attachment behaviour (Bowlby, 1969 cited by Hinde, 1982), and the use of ethological methods by Blurton-Jones (1972) and his colleagues to study child behaviour. Many subsequent studies have involved detailed observation of interactions between mothers and young children (Brown et al., 1975 cited by Huntingford, 1984). Huntingford (1984) argued that the fact that systematic observation of mother-child interactions provides one of the more reliable predictors of subsequent child abuse and neglect demonstrates the practical importance of such detailed behavioural analyses.

Huntingford (1984) presented a summary of the advantages and limitations of the ethological approach to the study of human behaviour. The advantages include that it forces observers to become familiar with their subjects and it encourages a degree of objectivity. Huntingford (1984) provided an example for this: a mother either touches her child or she does not, but whether she is warm or cold towards the child is a matter of opinion. In addition, focusing on small scale behavioural events sometimes allows behavioural features to be identified which might otherwise be missed, as well as giving information about the causal relationships between different items. When used in combination with analytical techniques for determining relationships between a number of distinct behaviour patterns, the ethological approach can provide information at a high level about how behaviour in humans is organised. Huntingford (1984) suggested that this may simply confirm or extend what is already known but it can provide new insights into the way human beings behave, and into the nature of behavioural abnormalities.

Limitations include that the ethological approach is time consuming to learn and apply; the enormous quantities of data it generates may be difficult to examine and analyse; and patterns at higher levels may be obscured. Techniques which accurately describe and measure social behaviour may also be inadequate for describing the subtle and more complex ways that humans interact, even when language is not important. Hinde (1982) and Huntingford (1984) proposed that to characterise a relationship between two people the observer must know how often they interact; the kind of behaviour they show; how much of the behaviour they show; how interactions are patterned in time and space, and how they are influenced by physical and social context. In addition, the quality of the relationship, whether it is reciprocal or not, and whether it is affectionate or not, may be important. Ethological methods and concepts can provide some but not all of the information necessary to describe and measure this complexity (Huntingford, 1984). Hinde (1979) has developed a hierarchical system based on an amalgamation of ethological and psychological techniques for describing and measuring the ways in which behavioural interactions constitute relationships and how these in turn combine to produce social organisation.

Human speech, together with the repertoire of accompanying non-verbal behaviours which can be investigated by observation alone, can also be accommodated within the ethological approach by incorporating behavioural categories such as 'vocalise' or 'shout'. Huntingford (1984), however, points out that the involvement of language adds a new dimension to social interactions which may completely alter the relationships identified by studies of overt behaviour alone. The observation of discrete items of behaviour in undisturbed encounters therefore has its limitations as a technique for investigating human behaviour (Cranach et al., 1979; Huntingford, 1984).

The Ethogram

The basis of each ethological investigation is the ethogram; the set of comprehensive descriptions of the characteristic behaviour patterns of a species (Lehner, 1996). It is the result of refining the catalogue of behaviours after many hours of observation and description. Descriptions of the behaviours in the ethogram should be clear, concise and complete (Lehner, 1996). Eibl-Eibesfeldt (1975) advised that functional units of behaviour which are neither too small nor too large should be selected for this behaviour inventory; the naming of behaviour patterns should be confined to descriptive terms; and that the description of a behaviour pattern should include each detail of the event, although in actuality such a physical description is never complete as the observer usually omits what is not important to him. He also suggested that the unbiased observation and recording of behavior patterns is a prerequisite for the scientific study of humans from an ethological point of view, and acknowledged that film and tapes have become the ethologist's most important tools for objective documentation of motor patterns (Eibl-Eibesfeldt, 1975).

When concept-orientated research is conducted, researchers may compile an ethogram of only those behaviours within, or closely related to, the category in which they are interested (Lehner, 1996). During the investigation reported in this thesis, the behavioural taxonomy or 'ethogram' detailed in Chapter 5 was developed to include behavioural descriptions which focused on night-time behaviour and interactions between mothers and their infants. The ethogram did not therefore include a complete catalogue of all mother and infant behaviours which may have been observed during a 24 hour period. Tinbergen has argued that the more we restrict our view of the individual's total behaviour patterns, the greater probability of misinterpreting results. He proposed that

> 'A broad, descriptive reconnaissance of the whole system of phenomena is necessary in order to see each individual problem in its perspective; it is the only safeguard for a balanced approach in which analytical and synthetical thinking can cooperate' (Tinbergen, 1953 cited by Lehner, 1996, p. 92).

With regard to mother-infant behaviour and interaction during the night, it is possible that day-time interactions influence behaviour at night, and it may have been useful to observe the mothers in this sample as they cared for their infants during the day.

However due to the fact that the majority of deaths attributed to SIDS occur during the night; the plethora of information already available in the literature with regard to day-time mother-infant interactions; the lack of direct knowledge regarding night-time infant care practices; together with the time, staff and resource limitations of this research project, a decision was made to focus only on night-time behaviour and interactions between mothers and their infants.

Sampling Methods

The investigation reported in this thesis was primarily an observational study of night-time mother-infant behaviour and interaction, with an experimental crossover design. One of the main aims of this study was to investigate and document the nature and extent of night-time behavioural interactions between mothers and their babies during times of sleep. As discussed in the previous chapter, the times at which mothers and their babies settled to sleep varied, so a sampling decision was made to focus on a comparable period of the night when the majority of mothers and babies had settled for their night's sleep. The main objective of the behavioural taxonomy was therefore to obtain the most complete account possible of all behaviours observed between mother-infant pairs during the designated five hour period, including specific behaviour units of interest, and data on occurrence, duration and sequences of both states and events relating to these behaviour units.

Methods employed for sampling these night-time behaviours, using the behavioural taxonomy specifically designed for this purpose, would be most accurately described as adaptations of sampling techniques commonly used for observational studies of behaviour. The sampling methods selected to gather data on night-time mother-infant behaviour and interactions were based on the research questions formulated for this study; the experimental design of the study; the number and type of behavioural units which were selected to be measured, including states and events; the scales of measurement used; and several practical considerations, including the observability of mother-infant behaviour in the laboratory, observer experience and the availability of equipment (Lehner, 1996).

Altmann (1974) and Lehner (1996) have presented detailed discussions on sampling methods commonly used in observational studies of behaviour, together with critiques and validations of these methods. For the purpose of this discussion, the sampling methods which were used in this investigation and the adaptations of previously described sampling methods, will be presented together with the rationales for why these methods were appropriate to use in this study.

Research objectives of this study required that detailed observations be made on two individuals. Sampling methods used in this investigation are best described as a combination of 'focal pair' sampling together with 'continuous 30 second scan sampling'. These methods are adaptations of the methods of focal animal/individual or focal subgroup sampling; together with continuous recording sampling, specifically all-occurrences sampling; and scan sampling, which is a form of time-sampling, and are all techniques previously described by Altmann (1974) and Lehner (1996).

'Focal pair' sampling was used in this study for documenting movements and noises produced by mothers and infants, together with mother-baby interactions, and met the criteria for focal individual sampling described by Altmann (1974): a) all occurrences of specified interactions of an individual or specified group, namely the mother-infant pair, were recorded during each sample period, and b) a record was made of the length of each sample period, and for each focal individual in the pair, the amount of time during the sample that it was actually in view. 'Focal pair' or what Altmann describes as 'subgroup' sampling is only practicable when it is possible to keep every member of the subgroup under observation during the sample period (Altmann, 1974). Sampling night-time mother-infant behaviour whereby both mothers and infant spent the vast majority of the observation period asleep and in a restricted area, i.e. one room and predominantly the bed, facilitated observation of the pair, thereby supporting the appropriateness of focal pair sampling as the method of choice.

The focal pair sampling used in this study focused primarily on behaviours which could be categorised as 'events' rather than 'states'. Altmann (1974) describes events as behaviours which are instantaneous. In acknowledging that the performance of any behaviour takes some amount of time, however brief, behaviours are also considered to be events when behaviours are considered at the moment of their onset, or at any other single, defining instant (Altmann, 1974), as movements, noises and interactions were in this study even when they sometimes involved appreciable durations.

With the 'focal pair' sampling method, behaviours of the mother-infant pair were accurately measured by observing only one individual at a time. This was made possible by playing the video data and the researcher observing either mother or baby, and then replaying the same video sequence to observe and record the same behaviours of movement and/or noise for the other member of the pair. In this way when the mother was the focal individual, a complete record was obtained not only of her actions, but also of behaviours directed to her by the baby, and vice versa. As explained by Altmann (1974) this means that a focal sample on the mother (or baby) provides a record of all acts in which she/he is either an 'actor' or a 'receiver', and were termed mother-initiated or baby-initiated interactions in this investigation. In addition, records of interactions during either focal sample or both together provided the necessary data for estimating their frequency or rate of interaction. In this investigation as observation times were equal for both mother and baby, the term frequency was used to mean number of occurrences, in accordance with convention in the statistical literature (Altman, 1991; Lehner, 1996). Without the assistance of video technology, it would have been difficult for one observer to record the behaviour accurately of two individuals simultaneously, and two observers would have been necessary; one observer to focus on the mother and one to focus on the baby, as suggested by Lehner (1996).

Focal animal or focal individual sampling should always be paired with other sampling methods, however is best suited to be paired with only some of those other methods (Lehner, 1996). The other units of behaviour which were documented using the behavioural code included mother and infant proximity, body position and orientation, physical contact, sleep/wake state and bedding arrangements. During data collection for these behaviours a modified version of continuous all-occurrences sampling combined with scan sampling, which recorded behaviours continuously for each 30 second interval during the five hour period, was used. The questions relating to these variables primarily involved the duration of these behaviours, or the percent of time spent in some activity, and were therefore questions about 'state'. The total sampling session of five hours was considered to be long enough to obtain an adequate estimate of the distribution of durations for these mother-infant behaviours (Altmann, 1974).

Lehner (1996) discussed all-occurrences sampling as a continuous recording sampling method. In this study a complete record of all behaviours during the night for both mother and infant was the aim, and therefore all occurrences were recorded. This method of sampling has also been described as complete record sampling (Slater, 1978). All-occurrence sampling and focal-individual sampling are often combined as it is difficult to record all occurrences accurately on several individuals simultaneously. This study design fulfils the following criteria proposed by Lehner (1996) for all-occurrence sampling of selected behaviours to be possible: a) the individuals and the behaviours were easily observed; b) the behaviours were carefully defined so that they were easily recognisable; and c) the behaviours did not occur more often (or more rapidly) than the observer could observe them. This method of sampling can provide accurate data on the frequency and rate of occurrence of the selected behaviours, restricted sequencing, and behavioural synchrony (Lehner, 1996). For example, the sleep staging data were examined for sequencing of sleep/wake states for the mother and infant separately, and then for concordance between sleep states between the mother-infant pair (behavioural synchrony).

Scan sampling was described by Lehner (1996) as a form of instantaneous sampling in which several individuals are scanned at predetermined points in time and their behavioural states are scored; that is, instantaneous samples are taken on several individuals at the same time. In some ways, scan sampling best describes the method used to document the behaviour units or 'states' of proximity, body position and orientation, physical contact, sleep staging, and bedding arrangements, which were recorded for each 30 second time interval. If the behaviour unit changed during the 30 second time period, e.g. contact to no contact, and the behaviour for that interval lasted longer than 15 seconds (over half the interval), then the behaviour was scored as occurring during the interval. One important use of scan sampling is to estimate the percentage of time spent that individuals spend in various activities or 'time budgets' (Altmann, 1974; Lehner, 1996). The duration of time spent in these states was the subject of interest, rather than rates and relative frequencies, and therefore scan sampling was an appropriate and time efficient method to use for these behaviour variables. The modification of this method to include continuous all-occurrence sampling however, also allowed data on when the state actually began and ended to be documented, which would allow more accurate calculations of duration for these states if necessary.

Breastfeeding episodes were recorded under the interaction section of the code, together with the commencement and cessation times of the episode, primarily using focal individual sampling methods. The continuous 30 second scan sampling technique was also used to find the breastfeeding episodes which occurred outside the 5 hour period of intensive video analysis, but which met the criteria for a breastfeeding episode. Frequency and duration of episodes were a subject of interest, and using Altmann's definitions a breastfeeding episode could be considered an event, as breastfeeds were considered at the moment of their onset and at the defining instant of 'nipple attachment', or as a state of feeding (Altmann, 1974).

For mothers and infants participating in this study, the pair was observed for the entire five hour period. Mothers were only out of the observer's view if they visited the nearby bathroom, and the times and durations of these visits were included in the behaviour record. These visits were only a few minutes in duration, and the vast majority of mothers did not leave the room during the five hour sampling period. Altmann (1974) and Lehner (1996) discussed ways in which to overcome the methodological problems of dealing with these 'out of sight' periods during focal individual or focal pair sampling. For out-of-sight periods of short duration and when the durations of common behaviours are long relative to the out-of-sight periods, as in this study, Lehner (1996) recommends that the observer either 1) assign the behaviour seen when the individual goes out-of-sight to the out-of-sight period, or 2) assign the behaviour seen when the individual comes back into view to the out-of-sight period. If the behaviour is the same for 1 and 2, then the behaviour recorded is more likely to be valid. During this study when mothers left or re-entered the room the movements involved with mobilising to or from the doorway to the bed or cot were grouped as leaving or entering the room and were recorded separately from previous movements which may or may not have involved interactions with their infants. When mothers left the room, they were recorded as being awake; head and body proximity relative to their infant was coded as over 60cm apart, and no physical contact with their infant occurred. These periods were included in the analysis for these variables as similar periods during the night in which mothers leave their infants to visit the bathroom may also occur under home conditions, and these variables were also known and observable, i.e. no physical contact with baby while mother out of room; mother awake while visiting bathroom. Data for physical orientation and body position during these periods which could not be observed were coded as 'don't know' and excluded from the analyses of these variables. Mothers were completely uncovered by bedding when they left the room, and these periods were excluded from the bedding analysis to give an accurate indication of bedding use by mothers whilst in bed.

As all effort was concentrated on only one pair and several behaviours at a time, focal pair sampling provided accurate data on frequencies and durations of behaviour when combined with all-occurrences sampling. Continuous record sampling methods document a complete account of all behaviour units of interest, including occurrence, duration and sequences of both states and events. Focal pair sampling, combined with a continuous 30 second scan sampling technique, resulted in a method of sampling very similar to all-occurrences sampling, and provided for a rigorous examination of the behaviour of the individuals who participated in this investigation. These adaptations are based on focal individual all-occurrences sampling which provides the most complete, accurate and valid data to test hypotheses (Lehner, 1996). For this reason, Altmann (1974) concluded that with proper choice of behaviour units, sample periods and focal individuals, this method is generally the best to use.

Summary

The ethological approach to human behaviour is seen by many as offering a way of looking at humans in a holistic and dynamic manner, preserving scientific precision, and placing human beings squarely in nature as part of the web of living organisms; all distinct yet interdependent. Ethology is an attempt to view humans as part of the natural world and as a product of evolution, dependent on its laws, and to be studied by the same approaches which are useful in studying the behaviour of other species (Burghardt, 1973).

All behavioural sciences are based on the assumption that predictions about behaviour can be made if a sufficient number of relevant variables are known. The combined sampling method of focal pair sampling and continuous 30 second scan sampling which were used in this investigation of night-time mother-infant behaviour and interactions were adaptations of ethological observation techniques which have been previously described and validated in the literature. These methods were successfully incorporated for use as scientific observation techniques in this study of night-time mother-infant behaviour and enabled maximum accuracy, reliability and efficiency of data collection and ensured that valid data were collected for testing the research hypotheses.

Part III

Results

Chapter 7

Results of Data Analysis

Ascertainment

Home Sleep Logs

Maternal reports of the infant's usual home sleep environment were confirmed by the home sleep logs which detailed sleep practices and breastfeeding behaviour for seven days after each monthly visit to the laboratory. All of the Routine Room-Sharing pairs returned the home sleep logs after each monthly visit providing a 100% response rate. Sixteen out of eighteen home sleep logs were returned in the Routine Bed-Sharing group providing an 89% response rate. The non-responders were two different mothers, and involved 2nd and 3rd visits respectively. On their next visit to the laboratory these mothers were asked about their sleep practices during the previous month which confirmed that they had continued to bed-share all night, every night. These mothers were not asked to complete questionnaires of practices for the week following their last study (up to four weeks previously), as recall of night-time breastfeeding behaviour has been shown to be unreliable (Quandt, 1987; Vitzthum, 1994a). Subsequent home sleep logs returned by these mothers confirmed that they continued to bed-share six hours per night, seven nights per week.

The home sleep logs which were returned indicated that during the five month study period all Routine Bed-Sharing pairs bed-shared for 7 nights per week, for at least 6 hours per night; and the Routine Room-Sharing pairs bed-shared no more than a median of 1 night per week (interquartile range 0-2 nights) for no more than 2-4 hours per night.

Reliability Checking

The intra- and inter-observer reliability checking which was performed showed very little difference in how a study was coded originally and how it was recoded. Discrepancies were rechecked and mutually agreed upon by both coders after re-examination of the original video data. See Appendix H for a detailed reliability checking report.

Sample Description

The sample consisted of ten mother-infant pairs of low risk for SIDS who met inclusion criteria. Table 7.1 shows interquartile and full ranges for maternal age and infant birth weight. The sample, inclusive of both groups, had a median maternal age of 32.5 years (interquartile range 29.3-34.8 years). All five Routine Room-Sharing mothers were primiparous and had a median age of 30 years (interquartile range 29-30.5 years). The Routine Bed-Sharing mothers were slightly older with a median age of 35 years (interquartile range 34-37 years), and three of the five mothers were multiparous, each with three to four other children.

Table 7.1 Maternal Age and Infant Birth Weight

		Total Sample n=10	RRS pairs n=5	RBS pairs n=5
Maternal Age (years)	Median	32.5	30	35
	Interquartile Range	29.3 - 34.8	29 - 30.5	34 - 37
	Full Range	25 - 39	27 - 33	25 - 39
Birth Weight of Infants (kilograms)	Median	3.48	3.18	3.77
	Interquartile Range	3.07 - 4.31	3.04 - 4.40	3.14 - 4.40
	Full Range	2.98 - 4.92	2.98 - 4.92	3.00 - 4.65

All of the babies were born by spontaneous vertex delivery at term and all infants had an Apgar Score of 9 or 10 at one minute and five minutes post delivery. The median birth weight for all infants was on the 50th centile [3.48 kg (interquartile range 3.07-4.31 kg)] according to current growth and developmental charts (Cooney, 1995). Infant weights have been described in terms of developmental centiles (Cooney et al., 1994; Cooney, 1995) to account for gender differences in weights between groups. The Routine Room-Sharing infants included three boys and two girls with a median birth weight between the 10th-50th centile. The Routine Bed-Sharing infants had a median birth weight on the 50th centile and included four boys and one girl. None of the infants had neonatal medical problems and all grew normally during the course of the study. Infant weights and head circumferences were plotted each month on a developmental chart (Cooney, 1995). At five months both Routine Bed-Sharing and Routine Room-Sharing babies had a median weight between the 50-90th centile (See Appendix I). The infants remained healthy throughout the study, although one routinely bed-sharing baby was hospitalised for one night with mild bronchiolitis, but required no specific treatment, and was clinically well with no residual symptoms at the time of the next study.

Data Exclusion

This study was designed to obtain 20 paired studies, or 40 nights recording from each of the Routine Bed-Sharing and Routine Room-Sharing groups; 5 pairs in each group attending 4 monthly studies. A paired study was defined as a room-sharing and a bed-sharing night occurring on consecutive nights for a mother-infant pair. A total of 749 hours of video and physiological data were recorded on 74 of a possible 80 nights.

The first visit, when the infant was approximately 4 weeks of age and mother and baby followed their usual sleep practice, was viewed as an 'adaptation' night and was not included in the analysis to control for 'first night' effects (Agnew et al., 1966; Berstein et al., 1976; McKenna and Mosko, 1994).

A total of 21 paired studies were obtained from the Routine Room-Sharing group. The first mother recruited into the study attended the laboratory when her infant was aged 3 weeks for her initial adaptation visit, and then commenced the monthly, paired night regime at 4 weeks of age, providing the additional paired study. For the Routine Bed-Sharing group, the recruitment of mothers meeting the inclusion criteria and maintenance of the design protocol proved more difficult. After attending the initial study night when the infant was four weeks of age, one Routine Bed-Sharing mother-infant pair decided not to participate in the study due to moving residence outside the Bristol-Bath area. Not all Routine Bed-Sharing mother-infant pairs had a room-sharing night and a bed-sharing night each month. One multiparous mother only attended the laboratory one night per month due to home commitments; two commenced the study at infant ages 2 months, and two mothers attended at infant ages 1, 3 and 5 months, due to staff resource limitations towards the end of the study period. This reduced the potential number of paired nights to 20. Due to technical problems in logging the physiological variables used to determine sleep state, one study night had to be excluded as missing data. Episodes of minor maternal or infant illness and difficulty getting RBS infants to settle in a cot on room-sharing nights further reduced the number of paired nights obtained to 12. Because of the importance of maintaining maternal cooperation with the studies, no attempts were made on these occasions to persuade the mothers to put their babies back into the cot if they showed reluctance in sleeping separately from their infant. Room-sharing nights in which Routine Bed-Sharing infants spent considerable time in bed other than for breastfeeding and settling after feeds were also excluded from the paired night data analysis.

Data included in analysis

Table 7.2 shows the data for which paired nights were obtained and which will be presented here. This totalled 563 hours of recording over 54 nights, with a full range of 7.8 to 12.6 hours of recording per night. For the Routine Room-Sharing group, 42 paired nights were obtained; and for the Routine Bed-Sharing group, 12 paired nights.

Table 7.2 Video Data used in Analysis

	Total Sample	RRS Pairs	RBS Pairs
Number of paired nights included in analysis	54	42	12
Total video recording for paired nights (hours)	563	440	123
Range of recording per night (hours)	7.8 - 12.6	7.8 - 12.6	9.0 - 11.3
Recording used for breastfeeding data (hours)	563	440	123
Recording used for all other variables (hours)	270	210	60

Analysis of breastfeeding behaviour included all feeds which occurred during the period of sleep, excluding the last feed before the infant went to sleep for the night, and the first feed in the morning after the infant was considered awake for the day. Video analysis for breastfeeding behaviours therefore included almost the entire night obtained for each paired recording, and therefore totalled 563 hours.

Analyses of the remaining variables were based on a five hour period sometime between 0100 and 0700 hours, commencing at the first minute of REM sleep, at or after 0100 hours; described in Chapter 5. The number of hours of video data which met the criteria for the paired night analysis totalled 210 hours for the Routine Room-Sharing group of mother-infant pairs, and 60 hours for the Routine Bed-Sharing group.

Data Sorting

All data were sorted by routine sleep condition and then again by sleep condition for the night. The four subgroups referred to in this chapter are: Routine Bed-Sharing pairs (RBS) on Bed-sharing Nights (BN); Routine Bed-Sharing pairs on Room-sharing Nights (RN); Routine Room-Sharing pairs (RRS) on Bed-sharing Nights, and Routine Room-Sharing pairs on Room-sharing Nights. Table 7.3 presents a breakdown of the number of nights and the number of video data hours used in the analysis for each of the four subgroups, excluding the breastfeeding variable.

Table 7.3 Subgroup Breakdown: Video Data used in Analysis (excluding breastfeeding variable)

Night Condition	*Group*	
	RRS Pairs	RBS Pairs
RN	21 nights 105 hours	6 nights 30 hours
BN	21 nights 105 hours	6 nights 30 hours

Analysis of variables by age

Most mother-infant pairs behaved consistently over time, with more variation between mother-infant pairs than between age groups. Graphically there appeared to be few age related trends in the data, most of them not significant in ANOVA analysis. Any differences which were found are addressed in each relevant section within the results.

Analysis of video data using the behavioural code

Effects of bed-sharing and room-sharing on maternal and infant sleep

Table 7.4 presents the proportions of the night that mothers and babies spent awake and asleep.

Table 7.4 **Distribution of Sleep/Wake States during the night for Mothers and Infants**

IQ range = interquartile range		*Group*	
Maternal Sleep/Wake States	*Night Condition*	RRS	RBS
Median % (IQ range) of night Mother awake	RN	24% (13-34%)	28% (19-44%)
	BN	36% (22-43%)	36% (22-47%)
Median % (IQ range) of night Mother asleep	RN	77% (63-87%)	73% (56-82%)
	BN	64% (57-78%)	64% (53-79%)
Infant Sleep/Wake States			
Median % (IQ range) of night Infant awake	RN	14% (7-23%)	22% (17-28%)
	BN	10% (2-14%)	19% (17-20%)
Median % (IQ range) of night Infant in REM sleep	RN	43% (34-48%)	42% (37-47%)
	BN	51% (41-56%)	35% (33-42%)
Median % (IQ range) of night Infant in Quiet sleep	RN	39% (36-40%)	35% (27-38%)
	BN	40% (35-42%)	42% (40-45%)

RRS on RN (n=105 hours) and BN (n=105 hours); RBS on RN (n=30 hours) and BN (n=30 hours)

All mothers spent more time awake during the night on bed-sharing nights than they did on room-sharing nights, regardless of routine condition, although these differences failed to reach significance. Consequently, both groups spent more time asleep on room-sharing nights than they did on bed-sharing nights.

Routine Bed-Sharing infants generally spent more time awake on both room-sharing and bed-sharing nights compared to Routine Room-Sharing infants. Routine Bed-Sharing infants spent the most time awake on their non-routine room-sharing night, while Routine Room-Sharing infants on their non-routine bed-sharing night spent the least time awake. This difference when comparing groups on their non-routine night did not quite reach significance (p=0.011). Interestingly, Routine Bed-Sharing and Routine Room-Sharing infants spent similar amounts of time awake on their routine night.

Routine Room-Sharing infants when bed-sharing had slightly more REM sleep than they did on room-sharing nights, and when compared to Routine Bed-Sharing infants on both nights, however these differences failed to reach significance. Infants in both groups also spent similar amounts of time in Quiet sleep on both night conditions.

Concordance between mother and infant sleep/wake states

Table 7.5 presents the concordance between sleep/wake states for mother-infant pairs demonstrated in this investigation.

Table 7.5 Concordance between Mother-Infant Sleep/Wake States

IQ range = interquartile range		*Group*	
	Night Condition	RRS	RBS
Median % (IQ range) of night Mother awake when Baby awake	RN BN	85% (34-95%) 85% (36-100%)	96% (78-98%) 99% (89-100%)
Median% (IQ range) of night Mother awake when Baby in REM sleep (using baby as reference point)	RN BN	21% (8-27%) 34% (16-45%)	9% (6-35%) 25% (7-44%)
Median % (IQ range) of night Baby in REM when Mother awake (using mother as a reference point)	RN BN	38% (21-48%) 52% (39-60%)	20% (12-28%) 27% (21-33%)
Median % (IQ range) night Mother asleep when Baby in Quiet Sleep	RN BN	90% (85-95%) 79% (69-89%)	88% (87-95%) 88% (74-95%)
RRS on RN (n=105 hours) and BN (n=105 hours); RBS on RN (n=30 hours) and BN (n=30 hours)			

Ratios of concordance found between the mother-infant sleep/wake state relationships were higher than would be expected by random association. The actual concordance shown in Table 7.5 is much greater than suggested by the predicted concordance shown in Table 7.6, for both groups and for all conditions. The only exception to this finding being the amount of time the mother was awake when the infant was in REM sleep for Routine Bed-Sharing mothers on their non-routine room-sharing night (predicted concordance of 12% Versus actual concordance of 9%).

Table 7.6 Predicted Concordance between Mother-Infant Sleep/Wake States			
IQ range = interquartile range		*Group*	
	Night Condition	RRS	RBS
Median % (IQ range) of night Mother awake when Baby awake	RN BN	4% (1-9%) 3% (0-5%)	6% (4 -13%) 7% (4 -11%)
Median% (IQ range) of night Mother awake when Baby in REM sleep (using baby as reference point)	RN BN	11% (5-14%) 15% (9-18%)	12% (9.5-15%) 13% (10-16%)
Median % (IQ range) of night Baby in REM when Mother awake (using mother as a reference point)	RN BN	11% (5-14%) 15% (9-18%)	12% (9.5-15%) 13% (10-16%)
Median % (IQ range) night Mother asleep when Baby in Quiet Sleep	RN BN	27% (20-36%) 25% (22-30%)	22% (20-27%) 23% (18-31%)
RRS on RN (n=105 hours) and BN (n=105 hours); RBS on RN (n=30 hours) and BN (n=30 hours)			

When their baby was awake, mothers in both groups were also awake for the majority of that time, with Routine Bed-Sharing mothers on bed-sharing nights awake virtually the entire time their infants were awake (median of 99%; interquartile range 89-100%). Routine Room-Sharing pairs showed no difference in the amount of time mothers were awake when their baby was awake when comparing bed-sharing and room-sharing nights. In comparison, Routine Bed-Sharing pairs demonstrated a pattern for greater concordance in awake states when bed-sharing than they did on room-sharing nights, which was also greater than Routine Room-Sharing pairs on room-sharing nights, although differences did not reach significance. See Table 7.5.

Mothers in both groups were more likely to be awake on bed-sharing nights when their infant was in active or rapid eye movement (REM) sleep, than they were on room-sharing nights. This effect was slightly greater for Routine Room-Sharing mothers when bed-sharing in the paired night analysis, but differences failed to reach significance.

When their infants were in Quiet sleep, mothers in both groups were also observed to be asleep for the majority of that time. See Table 7.5. Routine Bed-Sharing pairs showed no difference in the amount of time mothers were asleep when their baby was in Quiet sleep when comparing room-sharing and bed-sharing nights. In comparison, Routine Room-Sharing mothers spent significantly more time asleep when their baby was in Quiet sleep on their routine night than they did on bed-sharing nights (p=0.002).

When their mothers were awake, infants in both groups spent more of this time in REM sleep on bed-sharing nights compared to room-sharing nights, with this trend more evident in Routine Room-Sharing infants. See Table 7.5. The time Routine Room-Sharing infants spent in REM sleep while their mothers were awake on bed-sharing nights was significantly more than Routine Bed-Sharing infants did on both bed-sharing nights (p=0.001) and room-sharing nights (p=0.002).

Observations and analysis of sleep states in this study sample indicated that mother-baby sleep states demonstrated some concordance. Mothers in this sample were more likely to be awake when their infants were awake or in REM sleep, and were more likely to be asleep when their babies were in Quiet sleep. On bed-sharing nights in both groups, mothers were more likely to be awake when their infants were in REM sleep. Bed-sharing also appeared to impact on infant sleep state, as demonstrated by infants spending more time in REM when bed-sharing, and when their mothers were awake.

These general observations are demonstrated graphically using the examples of two mother-infant pairs and a comparison of their routine and non-routine nights. Figures 7.1 and 7.2 demonstrate the difference in concordance between room-sharing and bed-sharing nights for a Routine Room-Sharing pair, and Figures 7.3 and 7.4 demonstrate the difference in concordance shown by a Routine Bed-Sharing pair on the two night conditions.

Concordance of mothers' sleep with their babies' Quiet sleep increased with age, particularly on room-sharing nights, but these differences did not reach significance (p=0.04). No other age related trends were found.

Figure 7.1 Routine Room-Sharing Mother-Baby Pair on a Room-Sharing Night

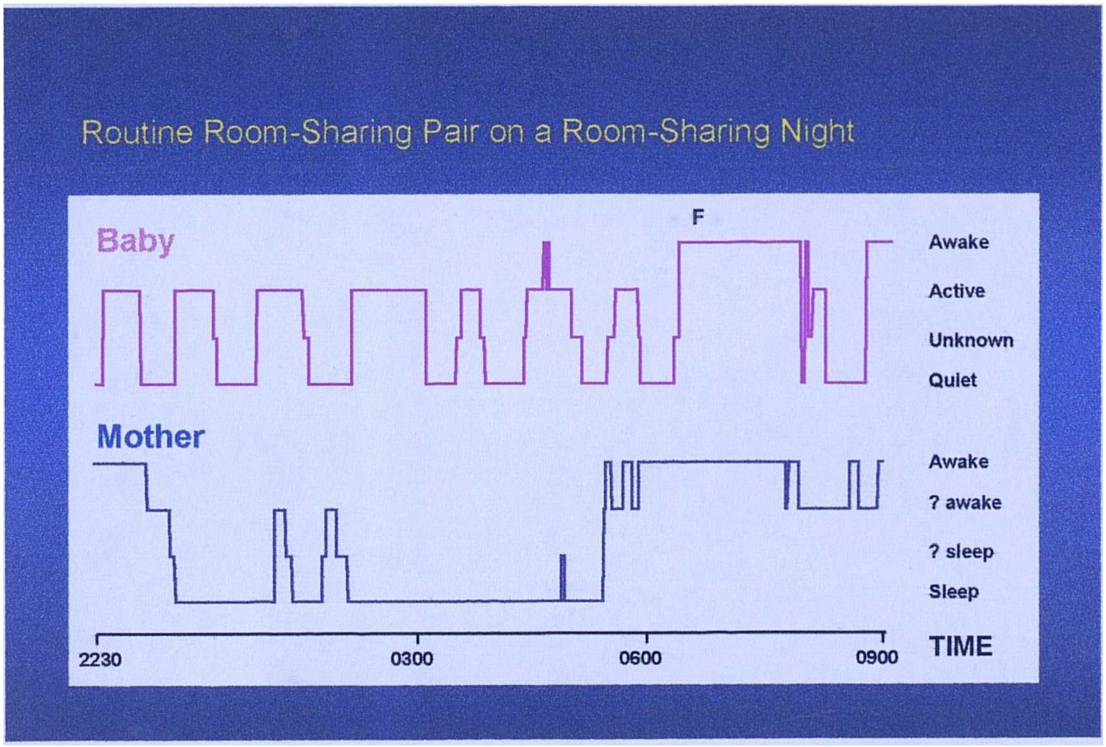


Figure 7.2 Routine Room-Sharing Mother-Baby Pair on a Bed-Sharing Night

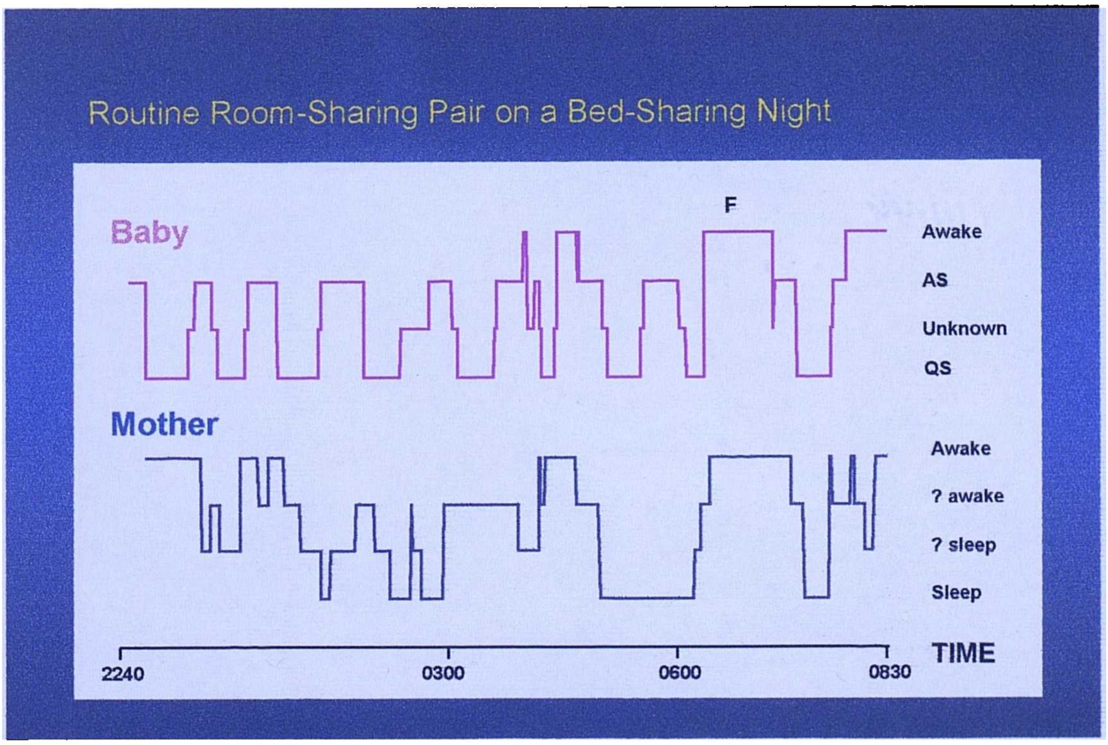


Figure 7.3 Routine Bed-Sharing Mother-Baby Pair on a Room-Sharing Night

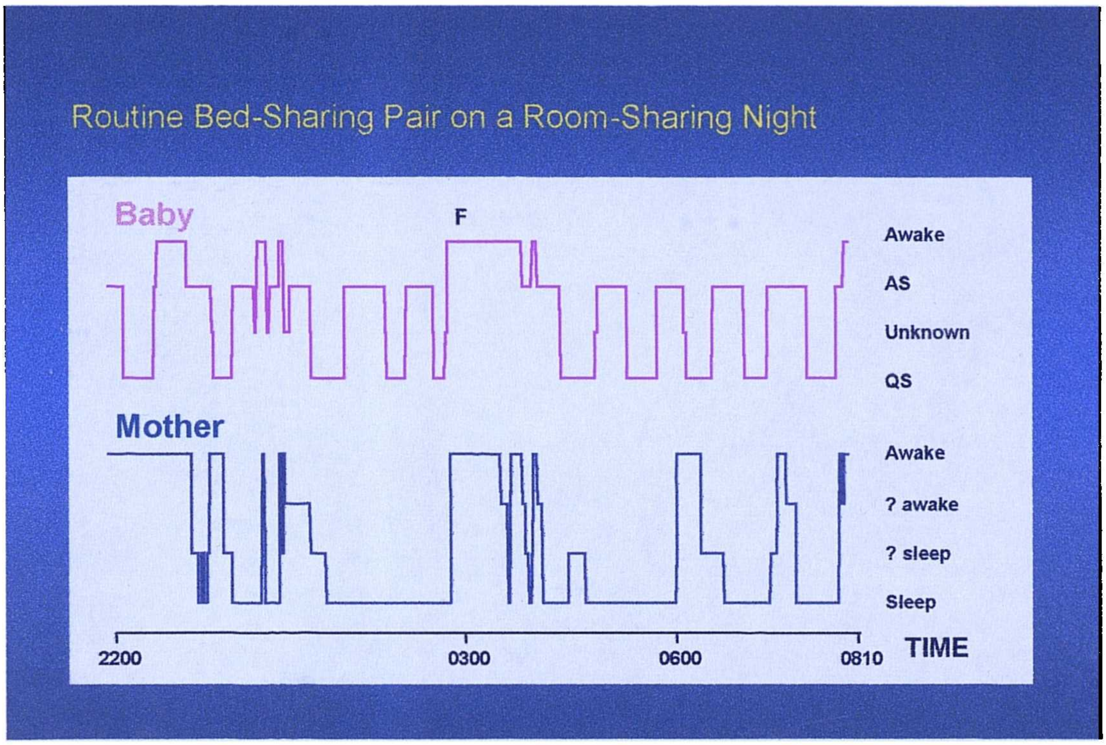
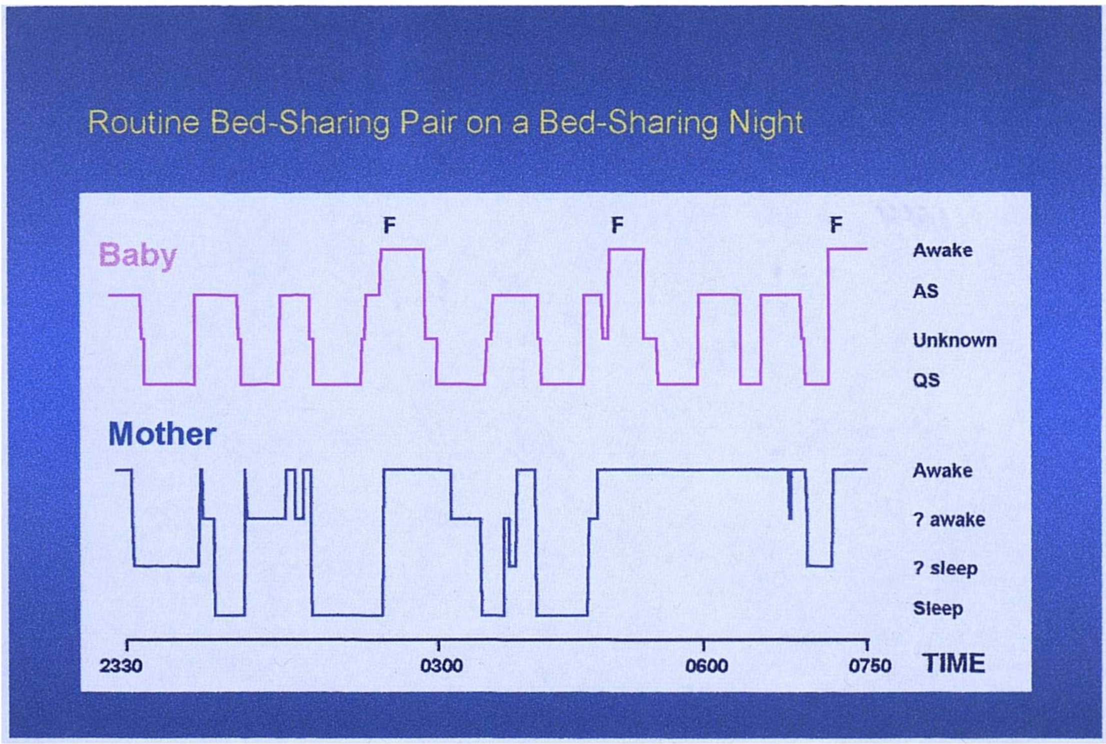


Figure 7.4 Routine Bed-Sharing Mother-Baby Pair on a Bed-Sharing Night



Interactions

Interactions which occurred between mother-infant pairs were most commonly initiated by a movement and/or noise produced by one member of the pair, which evoked a response by the other member. These behavioural interactions included feeding episodes; maternal and infant adjustment of body position; talking and whispering by mothers to their infants; cuddling, touching, stroking, patting and kissing of infants by their mothers, and mothers simply watching or checking their infants following movement or noise made by the baby. The frequency of interactions which occurred between mothers and infants during the night are presented in Table 7.7.

Table 7.7 Frequency of Night-time Interactions between Mother-Infant Pairs

IQ range = interquartile range		*Group*	
	Night Condition	RRS	RBS
Median (IQ range) number of all interactions	RN	16 (8-24)	23 (15-30)
	BN	25 (16-33)	32 (26-35)
Median (IQ range) number of Baby initiated interactions	RN	7 (4-11)	12 (9-14)
	BN	14 (10-24)	19 (17-22)
Median (IQ range) number of Mother initiated interactions	RN	3 (1-6)	3 (2-5)
	BN	7 (6-9)	5 (3-8)
Median (IQ range) number of Equally initiated interactions	RN	2 (0-11)	7 (3-11)
	BN	2 (0-3)	4 (4-5)

RRS on RN (n=105 hours) and BN (n=105 hours); RBS on RN (n=30 hours) and BN (n=30 hours)

The median number of all interactions occurring during the night, inclusive of baby, mother and equally initiated interactions, was greater for Routine Bed-Sharing pairs on both nights, and on bed-sharing nights in both groups. There was a trend for Routine Bed-Sharing pairs on bed-sharing nights to have more interactions occurring during the night when compared to Routine Room-Sharing pairs on room-sharing nights, but this difference did not reach significance (p=0.03). The median frequency of all interactions occurring during the night is also presented graphically in Figure 7.5.

Figure 7.5 Frequency of Interactions

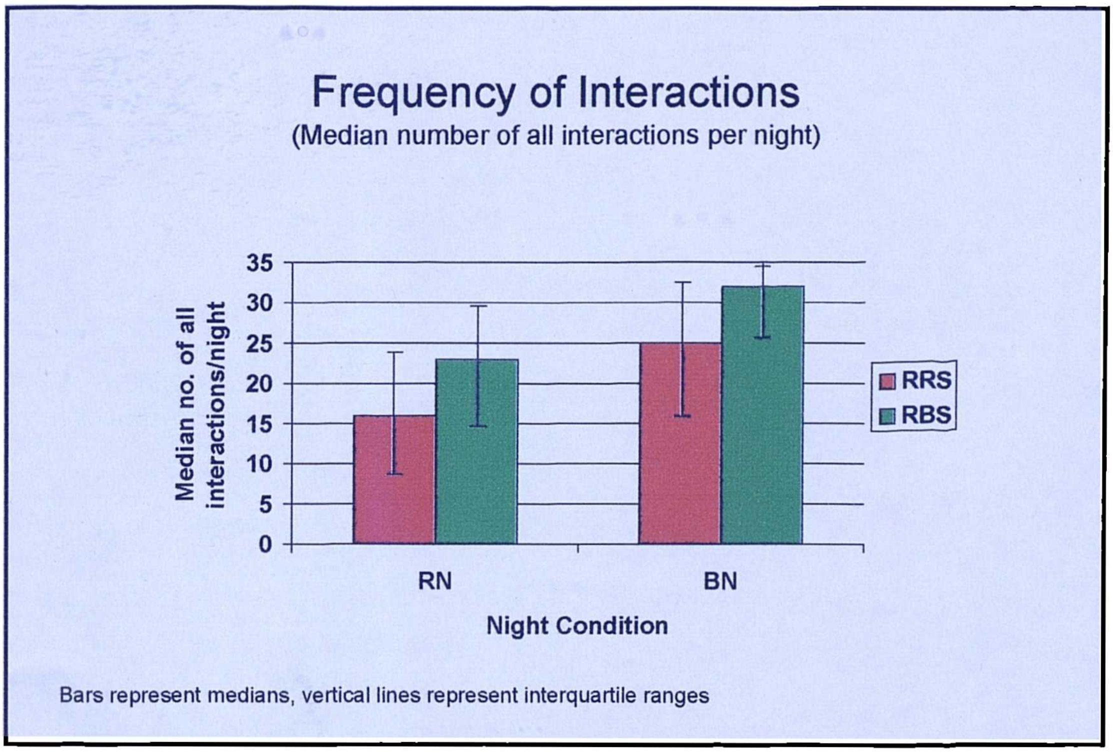


Table 7.8 presents the median response times of mothers and infants to interactions initiated by their mother or baby partner. The median response time when examining all interactions occurring during the night was shorter on bed-sharing nights compared to room-sharing nights in both groups. The shortest response time was for Routine Bed-Sharing pairs on bed-sharing nights, which was less than half the time they took to respond to interactions on their room-sharing nights; the longest response time for all of the subgroups (p=0.03). These differences were not significant at the 1% level.

Table 7.8 Response Times to Interactions initiated by Mothers and Infants

IQ range = interquartile range		*Group*	
	Night Condition	RRS	RBS
Median (IQ range) response time for all interactions (secs)	RN	15 (13-23)	24 (17-31)
	BN	14 (10-16)	11 (9-13)
Median (IQ range) response time of mother to baby initiated interactions (secs)	RN	17 (12-24)	26 (20-29)
	BN	13 (9-20)	12 (10-14)
Median (IQ range) response time of baby to mother initiated interactions (secs)	RN	7 (4-18)	20 (9-30)
	BN	11 (8-15)	10 (8-12)

RRS on RN (n=105 hours) and BN (n=105 hours); RBS on RN (n=30 hours) and BN (n=30 hours)

Babies initiated most of the interactions which occurred during the night. Routine Bed-Sharing infants initiated more interactions during both night conditions compared to Routine Room-Sharing infants, with the greatest difference observed between Routine Bed-Sharing infants on bed-sharing nights and Routine Room-Sharing infants on room-sharing nights. Infants in both groups initiated more interactions on bed-sharing nights compared to room-sharing nights, and for Routine Room-Sharing infants this was significant (p=0.0002). Mothers initiated more interactions when bed-sharing than they did on room-sharing nights, and this was significant for Routine Room-Sharing pairs (p=0.004). See Table 7.7.

Babies generally responded more quickly to their mothers than mothers did to baby initiated interactions. When sleeping in their routine condition, Routine Bed-Sharing and Routine Room-Sharing babies had very similar median response times to mother-initiated interactions (p=0.9). Interestingly, Routine Bed-Sharing babies had the longest median response time [median of 20 seconds (interquartile range 9-30)] of all the subgroups on their non-routine room-sharing night, although differences did not reach significance. The response times by mothers to baby-initiated interactions followed a similar pattern, although mothers in both groups had shorter response times on their bed-sharing night compared to room-sharing nights. On bed-sharing nights, Routine Bed-Sharing mothers demonstrated the shortest median response time to their babies. This was less than half the time taken to respond to interactions occurring on their room-sharing nights, the longest response time of the four subgroups, although differences did not reach significance (p=0.03).

Most of the equally initiated or 'simultaneous' interactions were part of feeds, and occurred more in Routine Bed-Sharing pairs compared to Routine Room-Sharing pairs, with Routine Bed-Sharing pairs on bed-sharing nights having twice as many equally initiated interactions as Routine Room-Sharers on bed-sharing nights (p=0.006). The number of equally initiated interactions decreased with age, particularly on bed-sharing nights, but this was not significant (p=0.03).

Frequency and Duration of Movements and Noises

Movement and noises produced by mothers and infants were examined in terms of frequency and total minutes per night to account for differences in movement and noise duration. The frequency and duration of movements and noises produced by infants, and interactions triggered by the stimuli of these movements and/or noises, are presented in Table 7.9.

Table 7.9 Frequency and Duration of Movement and Noise produced by Infants

IQ range = interquartile range		*Group*		p=
	Night Condition	RRS	RBS	0.60$^{\#}$
Median (IQ range) number of movements and/or noises produced by baby	RN	104 (87-131)	103 (88-115)	0.68††
	BN	102 (93-116)	106 (90-113)	0.79††
	p=	0.39†	0.75†	0.82‡
				0.005$^{\#}$
Median (IQ range) duration (minutes) of movements ± noises produced by baby	RN	48 (26-82)	81 (62-99)	0.12††
	BN	39 (24-48)	65 (40-68)	0.13††
	p=	**0.005†**	0.07†	1.00‡
				0.35$^{\#}$
Median % (IQ range) of baby movements and/or noises initiating interactions	RN	6% (4-10)	11% (9-17)	0.05††
	BN	16% (10-21)	19% (14-21)	0.45††
	p=	**0.0003†**	0.17†	0.02‡

Key: † Wilcoxon signed rank sum test: within group comparisons of the BN and RN

†† Mann Whitney U test: between group comparisons (RBS Vs RRS) for RN and BN

‡ Mann Whitney U test: between group comparison of routine nights : RRS on RN Vs RBS on BN

Mann Whitney U test: between group comparison of non-routine nights : RRS on BN Vs RBS on RN

RRS on RN (n=105 hours) and BN (n=105 hours); RBS on RN (n=30 hours) and BN (n=30 hours)

Babies produced similar numbers of movements or noises during the night in each of the four subgroups, but Routine Bed-Sharing infants spent slightly longer periods of time in movement or noise than Routine Room-Sharing infants, and this was significant when comparing non-routine nights (p=0.005). Both groups spent more time making movement or noise on room-sharing nights compared to bed-sharing nights; this was significant for Routine Room-Sharing babies (p=0.005).

Mothers demonstrated some similar patterns. The frequency and duration of movements or noises produced were greater for Routine Bed-Sharing mothers compared to Routine Room-Sharing mothers, and on bed-sharing nights compared to room-sharing nights. There was one exception in which Routine Bed-Sharing mothers spent longer periods of time making movement or noise on room-sharing nights compared to bed-sharing nights, although this difference did not reach significance (p=0.05). Table 7.10 shows the frequency and duration of movements and noises produced by mothers, and the interactions triggered by the stimuli of these movements and/or noises.

Table 7.10 Frequency and Duration of Movement and Noise produced by Mothers

IQ range = interquartile range		*Group*		p=
	Night Condition	RRS	RBS	0.93#
Median (IQ range) number of movements and/or noises produced by mother	RN	30 (16-40)	39 (32-40)	0.16††
	BN	41 (26-56)	49 (36-59)	0.60††
	p=	0.036†	0.92†	0.10‡
				0.036#
Median (IQ range) duration (minutes) of movements ± noises produced by mother	RN	20 (5-61)	49 (31-71)	0.13††
	BN	28 (6-35)	35 (20-55)	0.20††
	p=	0.11†	0.05†	0.52‡
				0.002#
Median % (IQ range) of mother movements and/or noises initiating interactions	RN	15% (3-24)	9% (8-12)	0.45††
	BN	2% (16-23)	11% (10-14)	0.03††
	p=	0.21†	0.75†	0.73‡

Key: † Wilcoxon signed rank sum test: within group comparisons of the BN and RN

†† Mann Whitney U test: between group comparisons (RBS Vs RRS) for RN and BN

‡ Mann Whitney U test: between group comparison of routine nights : RRS on RN Vs RBS on BN

Mann Whitney U test: between group comparison of non-routine nights : RRS on BN Vs RBS on RN

RRS on RN (n=105 hours) and BN (n=105 hours); RBS on RN (n=30 hours) and BN (n=30 hours)

The percentage of baby movements or noises which initiated an interaction, or response by their mother, was greatest for Routine Bed-Sharing pairs on both nights, and on bed-sharing nights for both groups. Routine Bed-Sharing babies on bed-sharing nights had the largest percentage of movements and noises which resulted in a maternal response. This was a median percentage three times more than Routine Room-Sharing babies on room-sharing nights who had the least, although this difference did not reach significance (p=0.02). See Table 7.9.

This pattern was not seen in the proportion of maternal movements or noises which initiated an infant response. On routine nights, Routine Room-Sharing and Routine Bed-Sharing pairs had a similar degree of maternal movements and noises which resulted in mother-infant interactions. However, Routine Bed-Sharing pairs had significantly more maternal movements and noises which resulted in an infant response than Routine Room-Sharing pairs when comparing non-routine nights (p=0.002).

For mothers and Routine Room-Sharing infants, movements without noise were more common than movements with noise. For Routine Bed-Sharing infants, the majority of movements were accompanied by noise. Time spent in movement was not much greater than the time spent making noise or making movements with noise. This indicated that movements accompanied by noise tended to have a much longer duration. Noises without movement were not common for babies or mothers. For babies these noises consisted mostly of squeaks, grunts or sighs during Quiet sleep.

The majority of baby initiated interactions were triggered by a baby movement accompanied by a noise [ranging from a median of 67% (interquartile range 26-80%) for RRS pairs on bed-sharing nights to a median of 72% (interquartile range 36-89%) for RBS pairs on room-sharing nights], although a substantial number were stimulated by movements only [median of 11% (interquartile range 6-22%) for RBS pairs on RN to median of 32% (interquartile range 20-74%) for RRS pairs on BN]. There were slightly more baby initiated interactions stimulated by movement only on bed-sharing nights for both groups, particularly for Routine Bed-Sharing pairs. There were few baby initiated interactions triggered by noise only, the range being from 0% to a median of 6% (interquartile range 0-14%) for Routine Bed-Sharing pairs on room-sharing nights. There was also a pattern on room-sharing nights for Routine Bed-Sharing pairs to have more baby initiated interactions triggered by noise only than Routine Room-Sharing pairs.

The reverse pattern was true for mother initiated interactions, with more mother initiated interactions triggered by maternal movement only [median of 62% (interquartile range

29-92%) for RBS pairs on room-sharing nights to a median of 89% (interquartile range 74-100%) for RRS on bed-sharing nights], than by movements accompanied by noises [median of 10% (interquartile range 0-25%) for RBS on bed-sharing nights to a median of 38% (interquartile range 8-71%) for RBS on room-sharing nights]. Very few interactions initiated by mothers were triggered by noise only [all subgroups had a median of 0%]. No significant differences were found between groups or between nights for the percentage of mother initiated interactions triggered by movements only; noises only, or movements and noises.

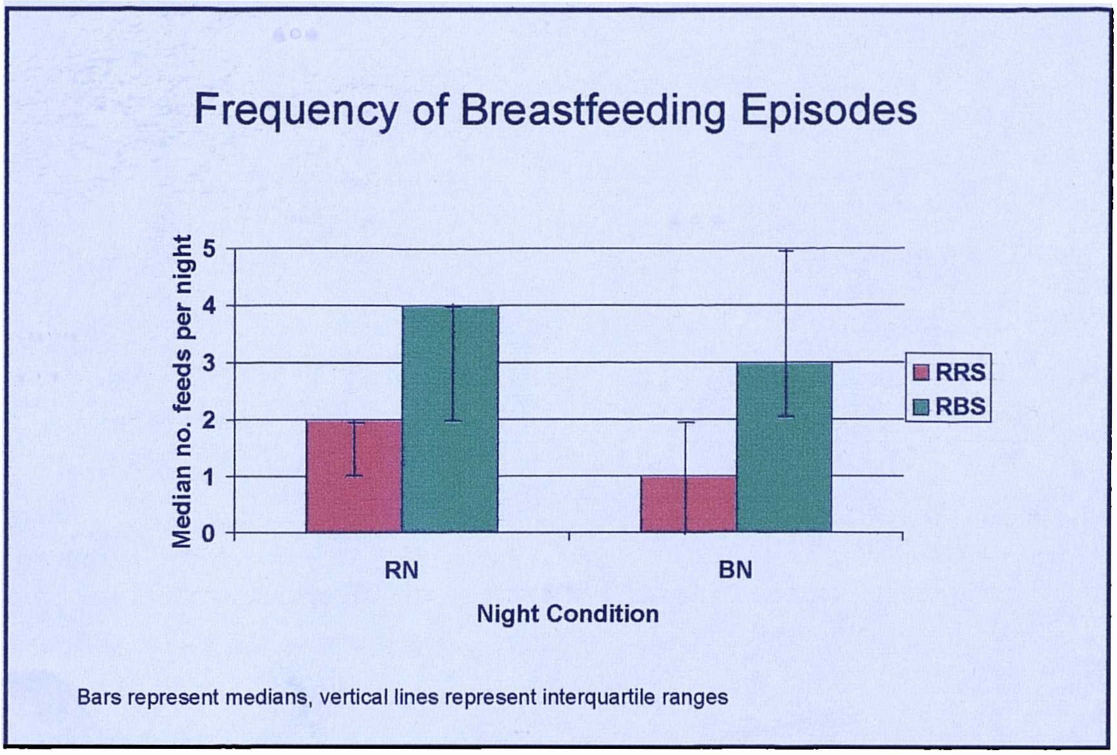
Breastfeeding Behaviour

Medians and interquartile ranges for the breastfeeding behaviours in each of the four subgroups are given in Table 7.11. The median number of breastfeeding episodes for Routine Bed-Sharing pairs was at least twice that of Routine Room-Sharing pairs for both night conditions, and Routine Bed-Sharing pairs on room-sharing nights had a median feed frequency four times greater than Routine Room-Sharing pairs on bed-sharing nights. These differences did not reach significance (p=0.02). The frequency of breastfeeding episodes is shown graphically in Figure 7.6.

Table 7.11 Breastfeeding Behaviour of Mother-Infant Pairs

IQ range = interquartile range		*Group*	
	Night Condition	RRS	RBS
Median (IQ range) frequency of episodes/night	RN	2 (1-2)	4 (2-4)
	BN	1 (0-2)	3 (2-5)
Median (IQ range) duration of episodes (minutes)	RN	14 (9-18)	9 (6-14)
	BN	14 (10-19)	7 (5-11)
Median (IQ range) of the mean duration of episodes (minutes)	RN	14 (7-18)	8 (6-12)
	BN	11 (0-19)	10 (6-15)
Median (IQ range) total feeding time (minutes)	RN	27 (17-35)	25 (10-55)
	BN	21 (0-29)	34 (25-37)
n = 563 hours total video hours; n=440 hours for RRS pairs; n=123 hours for RBS pairs			

Figure 7.6 Frequency of Breastfeeding Episodes



Some pairs in both Routine Room-Sharing and Routine Bed-Sharing groups exhibited a wide variation in the duration of breastfeeds, including comparatively short and long feeds during the same night. On many nights Routine Room-Sharing pairs did not feed at all however every Routine Bed-Sharing pair had one or more feeds during the night. To address this intra- and inter-individual variability, breastfeeding durations were analysed in two ways using 1) actual duration of breastfeeding episodes; and 2) median of the mean duration of a breastfeeding episode calculated for each night. Figure 7.7 presents the median duration of breastfeeding episodes. Individual feeding episodes were substantially shorter for Routine Bed-Sharing pairs on both night conditions compared to Routine Room-Sharing pairs, and this was significant when comparing bed-sharing nights ($p=0.002$). Mean feeding durations were also shorter for Routine Bed-Sharing pairs on both bed-sharing and room-sharing nights compared to Routine Room-Sharing pairs, however no significant differences were found. Consequently the total feeding time each night, although greatest for Routine Bed-Sharing pairs on their bed-sharing night, was not significantly different when comparing the two groups. Figure 7.8 is a graphical representation of the total time spent feeding during the night for Routine Room-Sharing and Routine Bed-Sharing pairs on both night conditions.

Figure 7.7 Median Duration of Breastfeeding Episodes

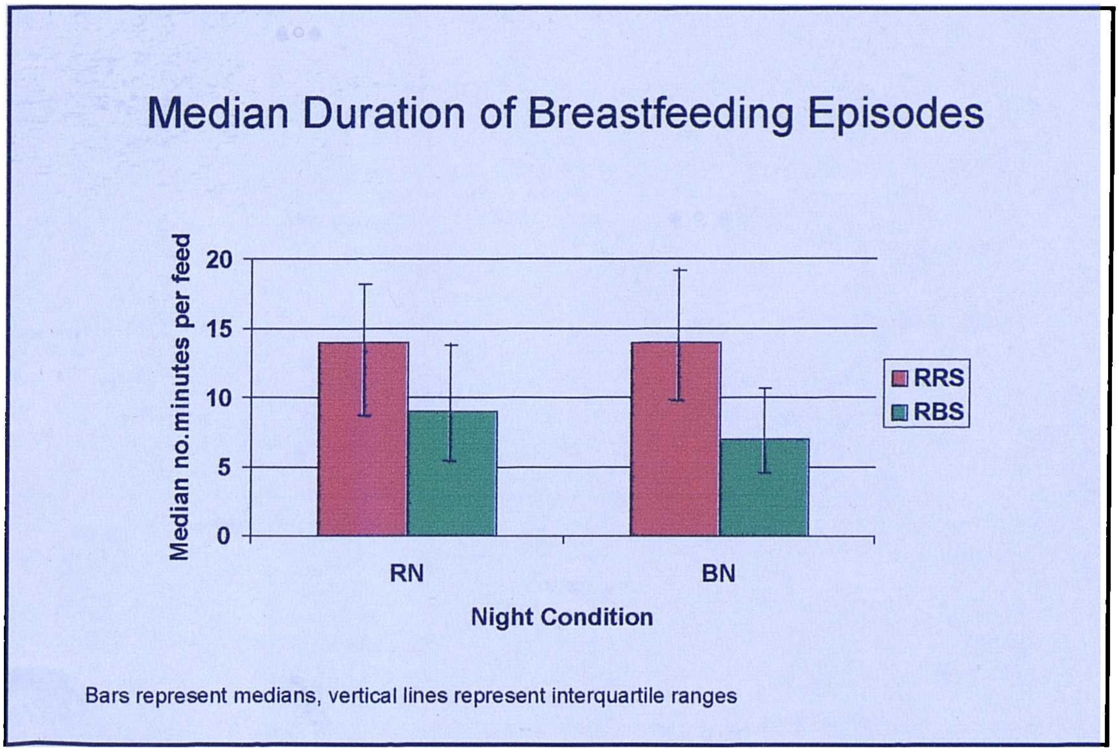
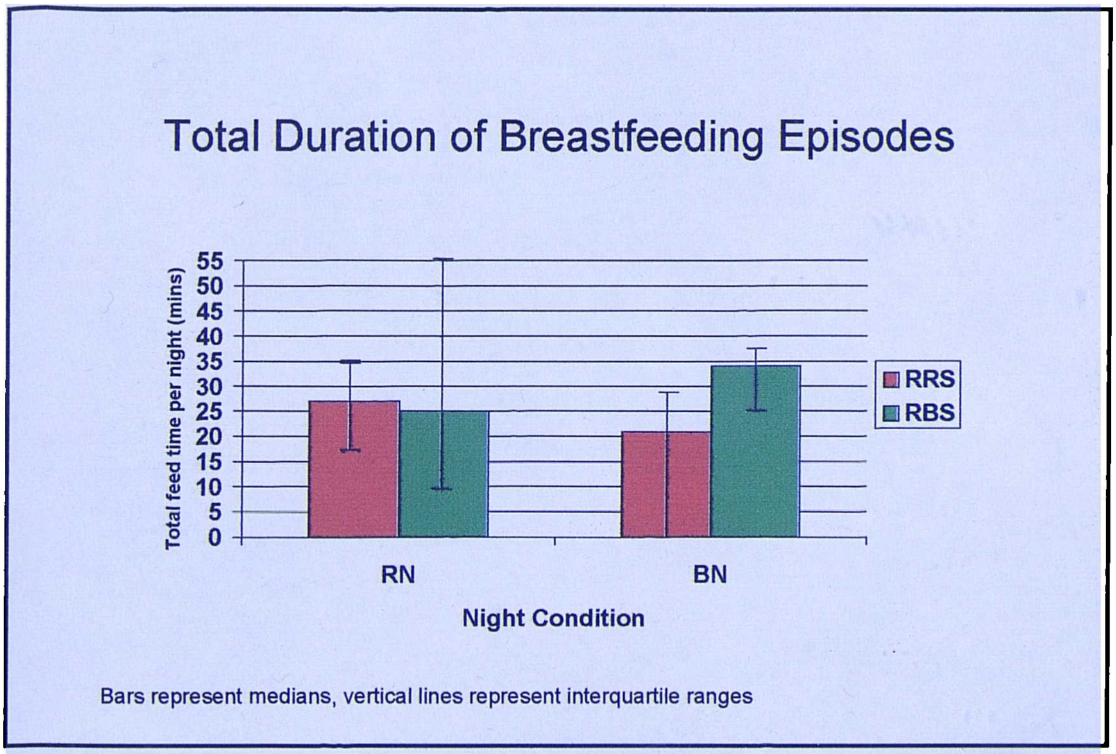


Figure 7.8 Total Duration of Breastfeeding Episodes



The number of self reported nocturnal breastfeeds was also derived from the 7 night home sleep logs. RBS pairs had a median of 2 feeds per night (interquartile range 2-3) compared with RRS pairs who reported a median of 1 feed per night (interquartile range 0-2), a significant difference of $p<0.0001$, consistent with our laboratory findings.

Overall, breastfeeding behaviours appeared to be related more to routine sleep condition than sleep type on the night. Routine Bed-Sharing pairs had more frequent breastfeeding episodes of shorter duration than Routine Room-Sharing pairs, while total feeding time per night was not significantly different between the two groups. Mothers from both groups often checked the time on their bedside clock as they began to feed their baby, and some mothers, particularly Routine Bed-Sharing mothers who fed lying down, were often observed to fall back to sleep during a breastfeed. The number of feeds per night also decreased slightly, but not significantly, with age.

Infant Sleep Position

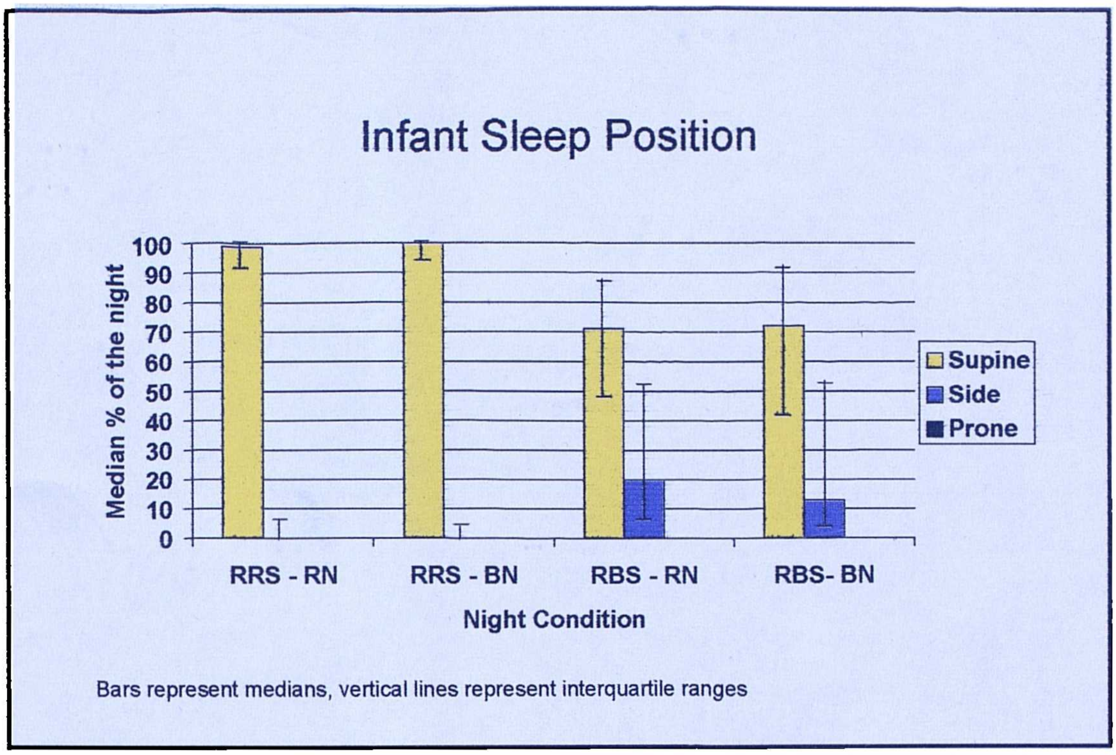
The amount of time infants spent sleeping prone, supine, or on their side, expressed as a percentage of the night, is given in Table 7.12 and shown graphically in Figure 7.9.

Table 7.12 Distribution of Infant Sleep Position during the night

IQ range = interquartile range		*Group*	
	Night Condition	RRS	RBS
Median % (IQ range) night infant is supine	RN	99% (92-100%)	71% (48-88%)
	BN	100% (94-100%)	72% (42-92%)
Median % (IQ range) night infant is on side	RN	0% (0-9%)	20% (8-52%)
	BN	0% (0-7%)	13% (6-53%)
Median % (IQ range) night infant is prone	RN	0% (0-0%)	0% (0-0%)
	BN	0% (0-0%)	0% (0-0%)
RRS on RN (n=105 hours) and BN (n=105 hours); RBS on RN (n=30 hours) and BN (n=30 hours)			

When placing infants down to sleep, either in the cot on room-sharing nights or on the bed when bed-sharing, all mothers were observed to position their infants supine. Routine Room-Sharing infants remained in the supine position for the vast majority of the night in both night conditions. In contrast, although Routine Bed-Sharing infants also spent the majority of both nights supine [median of 71% of night (interquartile range 48-88%) for RBS on room-sharing nights to a median of 72% (interquartile range 42-92%) for RBS on bed-sharing nights], it was significantly less than Routine Room-Sharing infants on both room-sharing nights (p=0.004) and bed-sharing nights (p=0.009), and when comparing routine (p=0.006) and non-routine nights (p=0.005).

Figure 7.9 Infant Sleep Position



Routine Bed-Sharing infants spent a substantial period of both night conditions in the side-lying position. Routine Room-Sharing infants were rarely observed to be placed on their side by their mother or to position themselves side-lying and hence spent considerably less time during the night in the side sleeping position, compared to Routine Bed-Sharing infants on both night conditions. This was significant when comparing bed-sharing nights (p=0.006) and non-routine nights (p=0.003).

Infants were rarely placed in the prone position. This practice was observed on three occasions, and only when babies were being settled to sleep on their mother's chest. On two of these occasions mothers were awake for the majority of the time their infants were prone [mother awake 92% of time infant prone for a RRS pair on a bed-sharing night; mother awake 100% of time infant prone for a RBS pair on a bed-sharing night]. On the third occasion, a Routine Bed-Sharing mother on a room-sharing night settled her infant to sleep, prone on her chest after a breastfeed, and fell asleep herself for short time before returning the infant to the cot [mother awake 25% of time infant prone].

Overall, infant sleep position appeared to be more related to routine sleep condition than sleep type on the night.

Illustration 7.1 Infants were only placed prone when settled to sleep on mother's chest

Proximity

The distance between mothers and babies during the night was expressed in multiples of 20 cm, and coded using a scale of 1-3, previously described in Chapter 5. Table 7.13 shows mother-infant proximity during the night. As one would expect, the median head and body distance between pairs during the night was less on bed-sharing nights compared to room-sharing nights for both groups. As a result, there were significant differences between groups when comparing routine night conditions. Routine Bed-Sharing and Routine Room-Sharing pairs demonstrated similarities in median head and body proximity when comparing the two night conditions. Overall, proximity appeared to be more related to sleep type on the night, rather than routine sleep condition.

Table 7.13 Proximity between Mother-Infant Pairs: Head and Body Distance				
IQ range = interquartile range		*Group*		p=
	Night Condition	RRS	RBS	**0.002#**
Median (IQ range) head distance (scale) between pair during night	RN	3 (3-3)	3 (3-3)	0.34††
	BN	2 (1-2)	2 (1-3)	0.92††
	p=	**0.0001†**	0.07†	**0.0005‡**
				<0.0001#
Median (IQ range) body distance (scale) between pair during night	RN	3 (3-3)	3 (2-3)	0.05††
	BN	1 (1-1)	1 (1-1)	0.90††
	p=	**0.0001†**	0.07†	**0.006‡**
Coding for Scale: Scale 1: Less than 20 cm; Scale 2: Between 20-60 cm; Scale 3: Greater than 60 cm.				
Key: † Wilcoxon signed rank sum test: within group comparisons of the BN and RN †† Mann Whitney U test: between group comparisons (RBS Vs RRS) for RN and BN ‡ Mann Whitney U test: between group comparison of routine nights : RRS on RN Vs RBS on BN # Mann Whitney U test: between group comparison of non-routine nights : RRS on BN Vs RBS on RN				
RRS on RN (n=105 hours) and BN (n=105 hours); RBS on RN (n=30 hours) and BN (n=30 hours)				

When bed-sharing, several differences were observed between Routine Room-Sharing and Routine Bed-Sharing pairs in the amount of time they spent at each of the three distances. The periods of the night mother-infant pairs spent in each of the specific categories for head distance are shown in Table 7.14. Routine Bed-Sharing pairs on bed-sharing nights were more likely to sleep with their heads less than 20 cm apart than they were with a head distance between 20-60 cm and over 60 cm. In contrast, Routine Room-Sharing pairs on bed-sharing nights spent longer periods of the night with head distances between 20-60 cm than they did at distances less than 20 cm. Routine Room-Sharing pairs also spent substantial periods of time with head distances greater than 60cm on bed-sharing nights. Although these differences between groups on bed-sharing nights did not reach significance, when comparing routine nights, Routine Bed-Sharing Pairs spent more of the night with their heads in close proximity to each other compared to Routine Room-Sharing pairs; and Routine Room-Sharing pairs spent significantly more of the night compared to Routine Bed-Sharing pairs with their heads over 60 cm apart (p=0.002).

Table 7.14 Head Proximity between Mothers and Infants during the night				
IQ range = interquartile range		*Group*		p=
	Night Condition	RRS	RBS	0.60#
Median % (IQ range) of night spent at distance < 20 cm	RN	0% (0-8%)	26% (8-31%)	**0.008††**
	BN	35% (2-57%)	51% (11-83%)	0.45††
	p=	**0.0004†**	0.17†	0.02‡
				0.003#
Median % (IQ range) of night spent at distance 20-60 cm	RN	1% (0-4%)	4% (1-4%)	0.20††
	BN	48% (31-61%)	22% (6-32%)	0.07††
	p=	**0.0001†**	0.08†	0.04‡
				0.001#
Median % (IQ range) of night spent at distance > 60cm	RN	96% (85-100%)	66% (54-87%)	0.03††
	BN	18% (2-25%)	4% (0-53%)	0.52††
	p=	**0.0001†**	0.028†	**0.002‡**

Key: † Wilcoxon signed rank sum test: within group comparisons of the BN and RN

†† Mann Whitney U test: between group comparisons (RBS Vs RRS) for RN and BN

‡ Mann Whitney U test: between group comparison of routine nights : RRS on RN Vs RBS on BN

Mann Whitney U test: between group comparison of non-routine nights : RRS on BN Vs RBS on RN

RRS on RN (n=105 hours) and BN (n=105 hours); RBS on RN (n=30 hours) and BN (n=30 hours)

Table 7.15 shows the periods of the night mother-infant pairs spent in each of the specific categories for body distance. Body distances followed similar patterns to head distance, although Routine Bed-Sharing pairs spent almost the entire night when bed-sharing with their bodies less than 20 cm apart. This indicated that mothers and infants slept with their bodies in closer proximity than their heads or faces. Although Routine Room-Sharing pairs demonstrated a wider variability in body distance, a greater percentage of the night was still spent less than 20 cm apart when bed-sharing.

Another important observation made was that at no time was any mother observed to roll on her baby, even when sleeping very close together. Overall, both Routine Room-Sharing and Routine Bed-Sharing pairs slept in closer proximity on bed-sharing nights compared to room-sharing nights, with a trend for Routine Bed-Sharing pairs to sleep closer together for longer periods during the night than Routine Room-Sharing pairs on both night conditions.

Table 7.15 Body Proximity between Mothers and Infants during the night

IQ range - interquartile range		*Group*		p=
	Night Condition	RRS	RBS	**0.004#**
Median % (IQ range) of night spent at distance 20 cm	RN	7% (0-17%)	34% (17-49%)	0.035††
	BN	92% (69-89%)	99% (79-100%)	0.29††
	p=	**0.0001†**	0.028†	**0.0004‡**
				0.10#
Median % (IQ range) of night spent at distance 20-60 cm	RN	0% (0-1%)	0% (0-1%)	0.71††
	BN	8% (0-27%)	0% (0-20%)	0.43††
	p=	**0.0038†**	0.69†	0.61‡
				0.0002#
Median % (IQ range) of night spent at distance > 60cm	RN	91% (83-100%)	65% (50-82%)	0.035††
	BN	1% (1-2%)	0% (0-0%)	0.039††
	p=	**0.0001†**	0.028†	**0.0002‡**

Key: † Wilcoxon signed rank sum test: within group comparisons of the BN and RN

†† Mann Whitney U test: between group comparisons (RBS Vs RRS) for RN and BN

‡ Mann Whitney U test: between group comparison of routine nights : RRS on RN Vs RBS on BN

Mann Whitney U test: between group comparison of non-routine nights : RRS on BN Vs RBS on RN

RRS on RN (n=105 hours) and BN (n=105 hours); RBS on RN (n=30 hours) and BN (n=30 hours)

Illustration 7.2 Mothers and infants commonly slept in close proximity when bed-sharing

Body Orientation

The period of the night that mothers and infants spent in body orientations which faced each other, is expressed as a percentage of the night, and is shown in Table 7.16. Babies generally spent more time in body orientations which faced their mothers, than mothers did in orientations which faced their babies. Routine Bed-Sharing babies spent very similar periods of the night facing their mother regardless of sleep condition, although there was a trend for infants in both groups to spend more time facing their mothers on bed-sharing nights compared to room-sharing nights. Routine Bed-Sharing infants also spent more time facing their mothers during both night conditions compared to Routine Room-Sharing infants, although differences between groups were not significant..

Table 7.16 Body Orientation of Mother-Infant Pairs

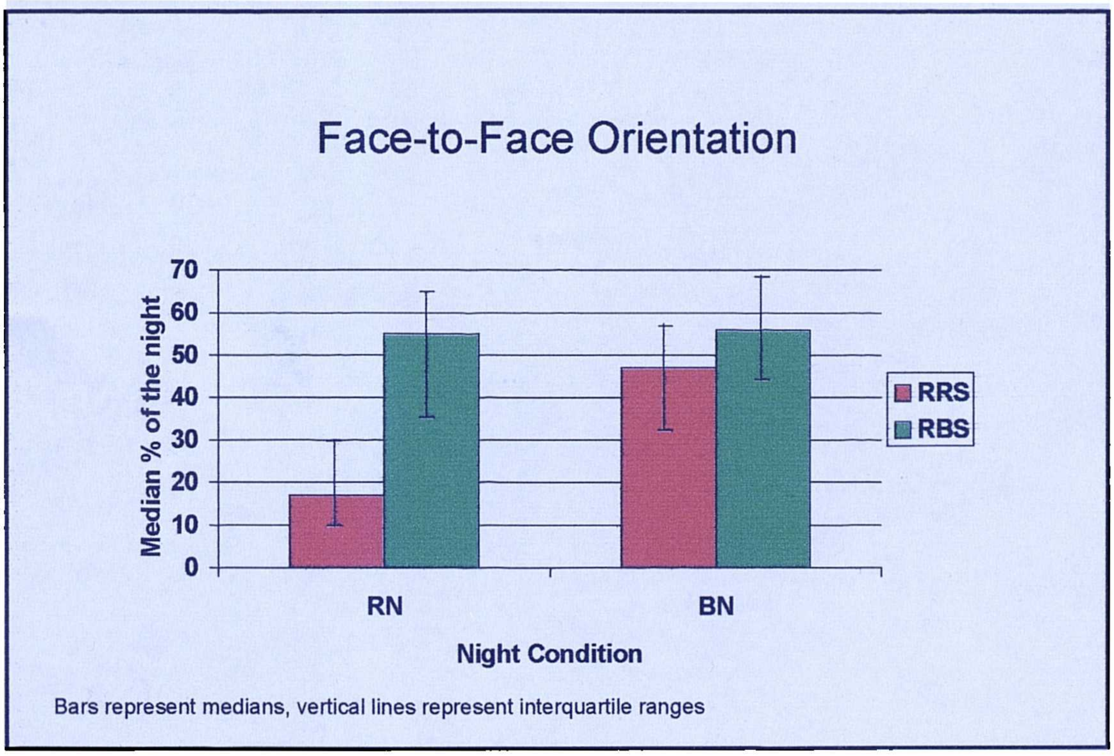
IQ range = interquartile range		*Group*	
	Night Condition	RRS	RBS
Median (IQ range) of night that baby faces mother	RN	48% (30-70%)	87% (82-91%)
	BN	68% (45-84%)	89% (71-95%)
Median (IQ range) of night that mother faces baby	RN	45% (41-59%)	56% (47-73%)
	BN	63% (57-71%)	71% (63-79%)
Median (IQ range) of night mother and baby are face-to-face	RN	17% (10-30%)	55% (34-64%)
	BN	47% (32-57%)	56% (45-69%)

RRS on RN (n=105 hours) and BN (n=105 hours); RBS on RN (n=30 hours) and BN (n=30 hours)

A similar pattern was seen for the period of time mothers assumed orientations which faced their infants. The period of the night in which mothers faced their infant was greater for Routine Bed-Sharing pairs on both nights, and on bed-sharing nights in both groups. Routine Room-Sharing mothers on room-sharing nights spent the least time facing their infants during the night, less than half the night, which was significantly less than they did on bed-sharing nights (p=0.001), and considerably less than RBS mothers on their routine bed-sharing night, although this did not reach significance (p=0.03).

The periods of the night mothers and infants spent orientated face-to-face followed a similar pattern as infants facing their mothers, and are presented in Figure 7.10. Routine Bed-Sharing pairs spent similar periods of the night facing each other regardless of night condition. There was a trend for greater periods of time spent face-to-face on bed-sharing nights compared to room-sharing nights for both groups, and this was significant for Routine Room-Sharing pairs (p=0.003). Routine Bed-Sharing pairs on both night conditions spent more than half the night facing each other on both night conditions, and this was significantly greater than Routine Room-Sharing pairs when comparing room-sharing nights (p=0.003) and routine nights (p=0.007).

Figure 7.10 Face-to-Face Orientation



The percentage of the night in which mothers faced their infants increased slightly with age in most pairs, particularly on room-sharing nights, however these differences were not significant.

Face-to-Face Proximity

Analysis of face-to-face proximity was performed in response to our observation that bed-sharing pairs, particularly Routine Bed-Sharing pairs, commonly slept facing each other at very close range. Overall, patterns of behaviour for proximity when face-to-face were very similar to patterns observed for proximity of mother-infant pairs in all positions, and for periods of the night spent in each of the specific distance categories. On bed-sharing nights, the median head distance between mother-infant pairs when face-to-face was the same or slightly less than the median head distance which included all positions. For Routine Bed-Sharing pairs on bed-sharing nights: median of scale 1.5 (interquartile range 1.0-2.8) when face-to-face Vs median of scale 1.5 (interquartile range 1.0-2.8) when all positions were included; and for Routine Room-Sharing pairs on bed-sharing nights: median of scale 1.0 (interquartile range 1.0-2.0) when face to face Vs median of scale 2.0 (interquartile range 1.0-2.0) when considering all positions.

Face-to-face proximity when bed-sharing is shown in Figure 7.11. When bed-sharing and in a face-to-face orientation, both groups spent more time during the night with their faces less than 20 cm apart than they did in any other distance category, although RBS pairs spent slightly more time in this close proximity than Routine Room-Sharing pairs [median of 30% of night (interquartile range 5-56%) for RBS on bed-sharing nights Vs median of 21% (interquartile range 2-38%) for RRS on bed-sharing nights]. When bed-sharing, RRS pairs also spent a substantial period of time between 20-60 cm [14% of the night (interquartile range 5-28%)], which was more than RBS pairs [median of 5% of night (interquartile range 1-13%)]. Neither group spent much of the night greater than 60 cm apart. These differences between groups did not reach significance.

Figure 7.11 Face-to-Face Proximity when Bed-sharing

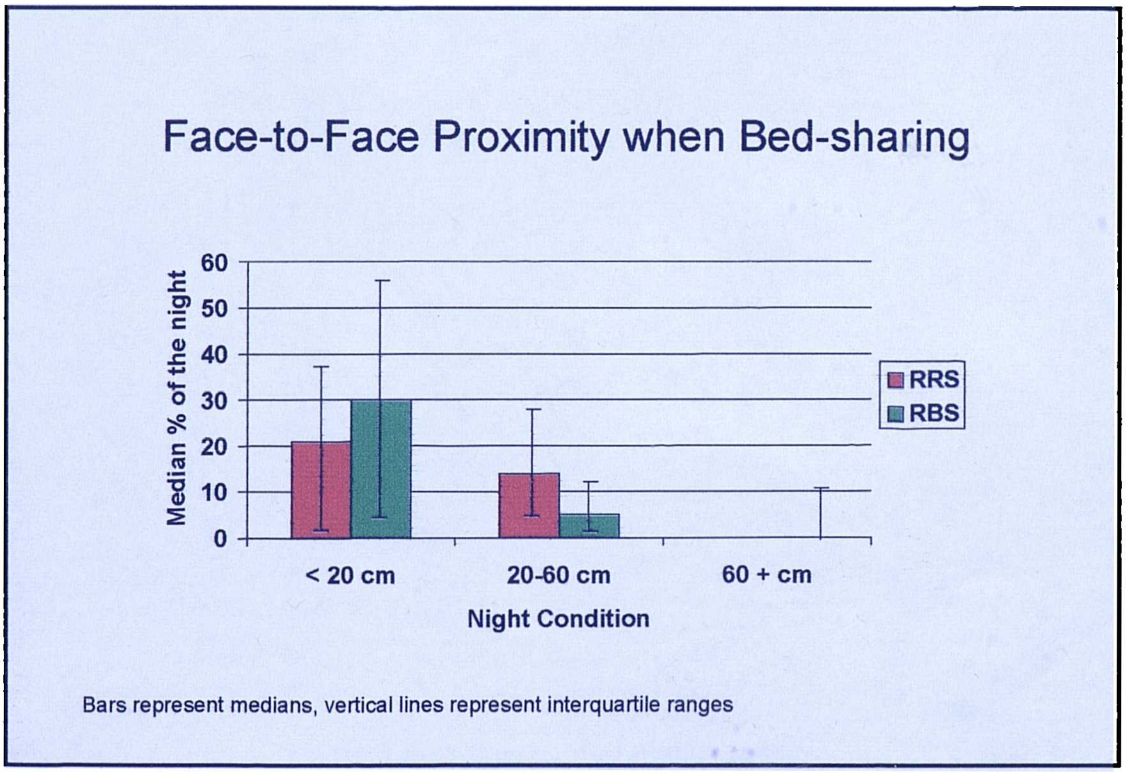


Illustration 7.3 Bed-sharing pairs often slept face-to-face at close proximity

Physical Contact

Figure 7.12 shows the amount of time mother-infant pairs spent in physical contact with each other. The amount of time spent in contact during the night was greatest for Routine Bed-Sharing pairs on both nights, and on bed-sharing nights for both groups. Routine Room-Sharing pairs on room-sharing nights spent the least amount of time in physical contact with each other [median of 4% of night (interquartile range 0.3-17%)]. This was significantly less than on their bed-sharing nights [median of 24% of night (interquartile range 10-55%), p=0.002], and considerably less than Routine Bed-Sharing pairs on both bed-sharing [median of 44% of night (interquartile range 22-86%), p=0.01] and room-sharing nights [median of 34% of night (interquartile range 16-50%), p=0.02], although these differences did not reach significance. See Illustration 7.4. Another observation of maternal behaviour with regard to physical contact during the night, was that mothers in both groups tended to communicate with their babies at night through touch, rather than using verbal communication, although this was not easily quantifiable. For example, mothers would often respond to an infant arousal by briefly touching the infant's hand, or adjusting bedding, rather than by talking to the infant. Verbal communication by mothers to infants which did occur during the night was predominantly in whispered tones.

Figure 7.12 Night-time Physical Contact

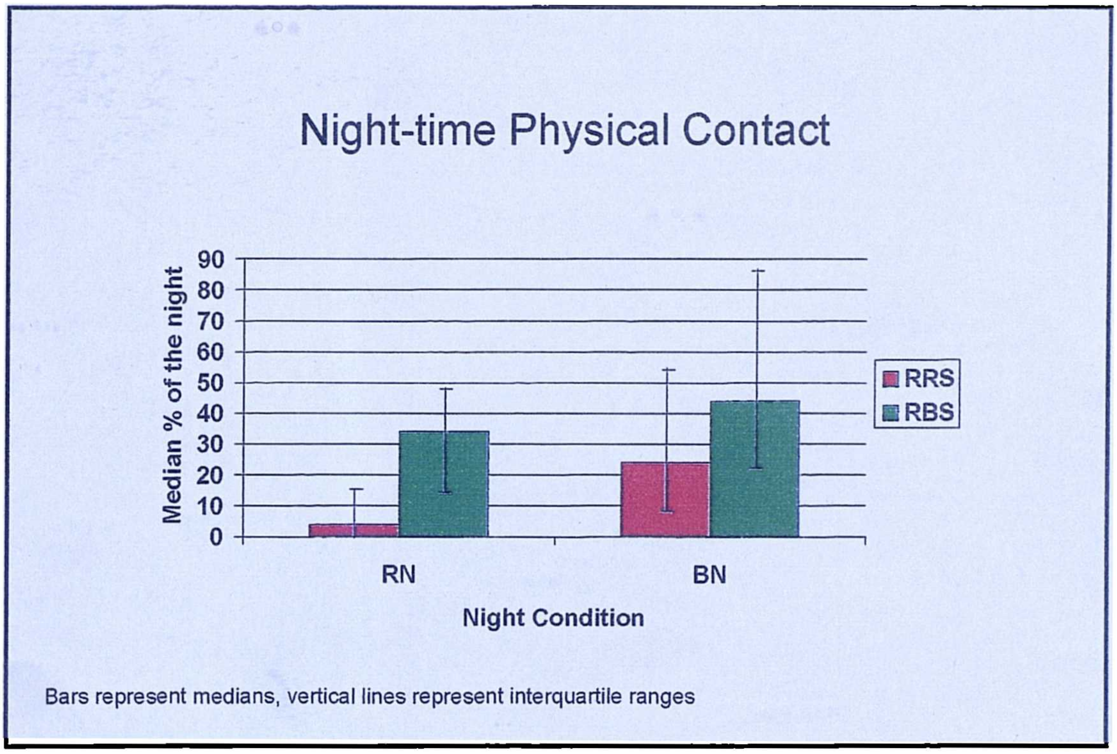


Illustration 7.4 Mother and baby in close physical contact during bed-sharing

Bedding Arrangements

Mothers were free to choose the bedding and clothing they used to cover themselves and their infants, including any bedding they had brought with them from home. On all nights infants wore a disposable nappy, and the majority wore a vest (0.2 tog) and stretch cotton babygro with feet (1.0 tog); although on several nights some mothers only used a babygro, or a vest, and not both. Disposable nappies were not included in tog calculations due to the difference between wet (0.1 tog) and dry disposable nappies (0.6 tog), and the effect from nappies on overall insulation was considered negligible, as documented elsewhere (Fleming et al., 1990; Clulow, 1987). A 10 tog duvet was available in the laboratory together with a selection of cellular baby blankets (1.5 tog per layer). All mothers chose to utilise the bedding provided in the laboratory. Table 7.17 presents the type and number of layers of bedding used to cover infants at night.

Table 7.17 Type and Layers of Bedding used for Infants during the night

IQ range = interquartile range		*Group*	
	Night Condition	RRS	RBS
Median % (IQ range) night infant covered by duvet	RN	0% (0-7%)	16% (4-29%)
	BN	82% (0-95%)	94% (38-97%)
Median % (IQ range) night infant covered by 1 air cell	RN	0% (0-0%)	0% (0-0%)
	BN	0% (0-0%)	0% (0-0%)
Median % (IQ range) night infant covered by 2 air cells	RN	0% (0-7%)	11% (1-33%)
	BN	0% (0-15%)	0% (0-0%)
Median % (IQ range) night infant covered by 3 air cells	RN	0% (0-0%)	19% (3-31%)
	BN	0% (0-0%)	0% (0-0%)
Median % (IQ range) night infant covered by 4 or more air cells	RN	25% (0-88%)	14% (0-55%)
	BN	0% (0-0%)	0% (0-0%)

RRS on RN (n=105 hours) and BN (n=105 hours); RBS on RN (n=30 hours) and BN (n=30 hours)

Routine Bed-Sharing pairs shared a duvet for the majority of the night when bed-sharing [median of 94% of night (interquartile range 38-97%)]. On two separate occasions one Routine Bed-Sharing mother used blankets to cover her infant for part of the night [19% and 34% of night respectively] when bed-sharing. When infants slept in the cot on room-sharing nights, Routine Bed-Sharing mothers were observed to use 3 layers of cellular bedding to cover infants more than any other combination of layers [median of 19% of night (interquartile range 3-31%). Routine Bed-Sharing infants also spent a substantial period of the night covered by 4 layers and 2 layers of blankets respectively, on room-sharing nights.

When bed-sharing, Routine Room-Sharing pairs shared a duvet for a median of 82% of the night (interquartile range 0-95%) and were more likely to use a combination of blankets to cover infants. One Routine Room-Sharing mother routinely swaddled her infant in early infancy (at ages 1-3 months) in several layers of blankets when room-sharing, and when bed-sharing placed her infant on top of the duvet. On room-sharing nights, Routinely Room-sharing mothers were more likely to cover infants with 4 or more layers of cellular blanket than any other combination of layers [median of 25% of night (interquartile range 0-88%)].

Table 7.18 shows the level of the body to which bedding was placed on infants at night.

Table 7.18 Position of Bedding on Infants' Body during the night

IQ range = interquartile range		*Group*	
	Night Condition	RRS	RBS
Median % (IQ range) night bedding at Level 1	RN	0% (0-2%)	9% (0-11%)
	BN	0% (0-11%)	17% (3-25%)
Median % (IQ range) night bedding at Level 2	RN	67% (7-100%)	67% (45-91%)
	BN	91% (53-100%)	50% (21-82%)
Median % (IQ range) night bedding at Level 3	RN	1% (0-64%)	6% (4-12%)
	BN	0% (0-1%)	3% (0-11%)
Median % (IQ range) night bedding at Level 4	RN	0% (0-0%)	9% (0-1%)
	BN	0% (0-0%)	0% (0-0%)
Median % (IQ range) night bedding at Level 5	RN	2% (0-8%)	2% (1-15%)
	BN	2% (0-8%)	3% (1-21%)
Median % (IQ range) night bedding at Level 6	RN	0% (0-0%)	0% (0-0%)
	BN	0% (0-0%)	0% (0-0%)

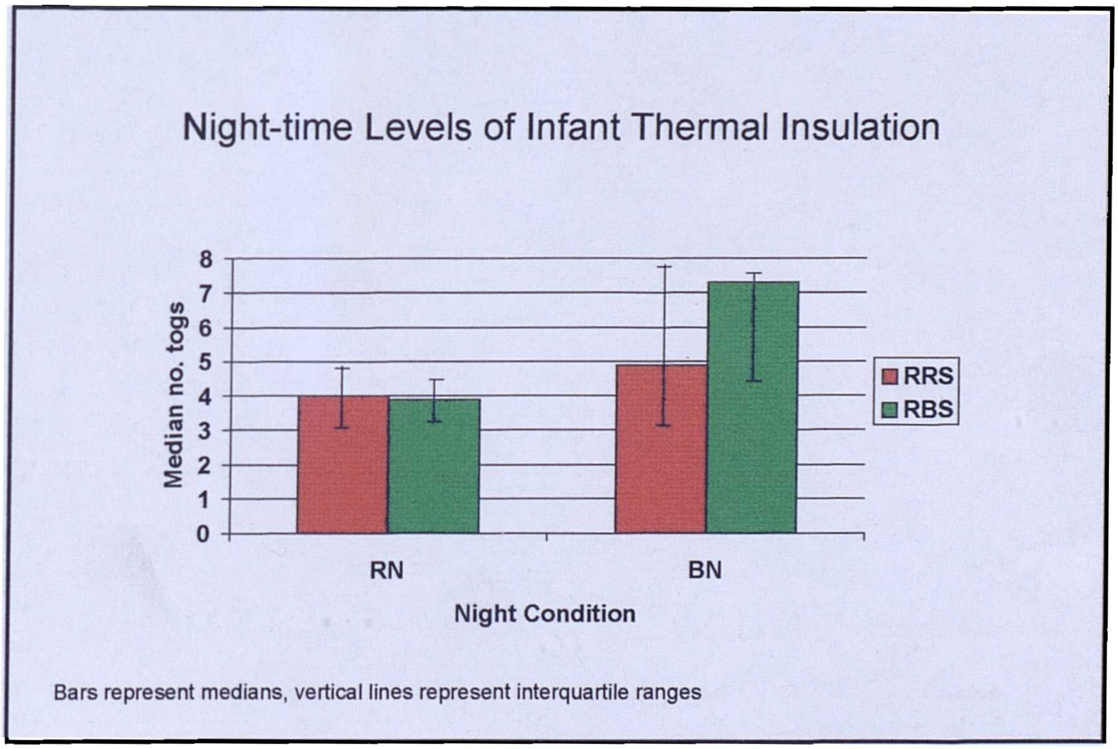
Key: Level 1 Trunk to shoulder level (neck) with both arms covered
Level 2 Trunk to shoulder level with one or both arms uncovered
Level 3 Trunk to midchest (epigastric) level
Level 4 Trunk to level of hips
Level 5 Body completely uncovered by bedding
Level 6 Head and body completely covered by bedding

RRS on RN (n=105 hours) and BN (n=105 hours); RBS on RN (n=30 hours) and BN (n=30 hours)

Mothers, in both groups and on both nights, most commonly arranged bedding at the level of their infants' shoulders with one or both arms free [median of 50% of night (interquartile range 21-82%) for RBS on bed-sharing nights to median of 91% of night (interquartile range 53-100%) for RRS on bed-sharing nights]. Differences between groups were not significant. Routine Bed-Sharing infants on bed-sharing nights were also observed to spend a substantial part of the night [17% of night (interquartile range 3-25%)] with bedding at the level of the shoulders (neck), with both arms covered, which was greater than Routine Room-Sharing infants on room-sharing nights [median of 0% of night (interquartile range 0-2%), p=0.02). This difference did not reach significance.

These observations were reflected by tog units calculated for bedding and clothing used by mothers for infants. Figure 7.13 presents the levels of thermal insulation covering infants at night.

Figure 7.13 Night-time Levels of Infant Thermal Insulation



Median levels of thermal insulation, as indicated by number of togs, were higher on bed-sharing nights for both Routine Room-Sharing and Routine Bed-Sharing groups of babies, with the highest level of thermal insulation used for Routine Bed-Sharing babies on bed-sharing nights [median of 7.3 togs (interquartile range 4.6-7.5) for RBS babies on bed-sharing nights, compared to 4.9 togs (interquartile range 3.3-7.7) for RRS on bed-sharing nights]. On room-sharing nights, levels of insulation used for Routine Bed-Sharing and Routine Room-Sharing babies were very similar [median of 3.9 togs (interquartile range 3.3-4.5) for RBS babies on room-sharing nights versus median of 4.0 togs (3.2-4.9) for RRS infants on room-sharing nights].

The difference between the levels of insulation placed on infants by mothers when comparing room-sharing and bed-sharing nights was not significant for the Routine Room-Sharing group (p=0.1), however more togs were used on the bed-sharing night. It is possible that this non-significant result was partly due to the fact that blankets were used to cover babies on some bed-sharing nights by some Routine Room-Sharing mothers, and one mother on a room-sharing night swaddled her baby, which doubled the thermal insulation of the bedding. A significant value may have been obtained with a larger sample size. The sample size for the Routine Bed-Sharing group was too small to make the same comparison between room-sharing and bed-sharing nights for levels of thermal insulation placed on babies by mothers.

Infants, in both groups and on both nights, were observed to kick off or wriggle free of bedding so as to become completely uncovered for short periods during the night [median of 2% of night (interquartile range 0-8%) for RRS on both room-sharing and bed-sharing nights to median of 3% of night (interquartile range 1-21%) for RBS on bed-sharing nights]. Infants were more likely to be awake when they were completely uncovered by bedding [median of 84% of night (interquartile range 66-96%) for RBS on room-sharing nights to a median of 100% of night (interquartile range 62-100%) for RRS on bed-sharing nights]. Infants were rarely observed to become completely covered by bedding, and never when bed-sharing with their mothers in the paired night analysis.

Mothers in both groups used a duvet on both night conditions. Table 7.19 shows the level of the body to which bedding was placed by mothers on themselves during the night.

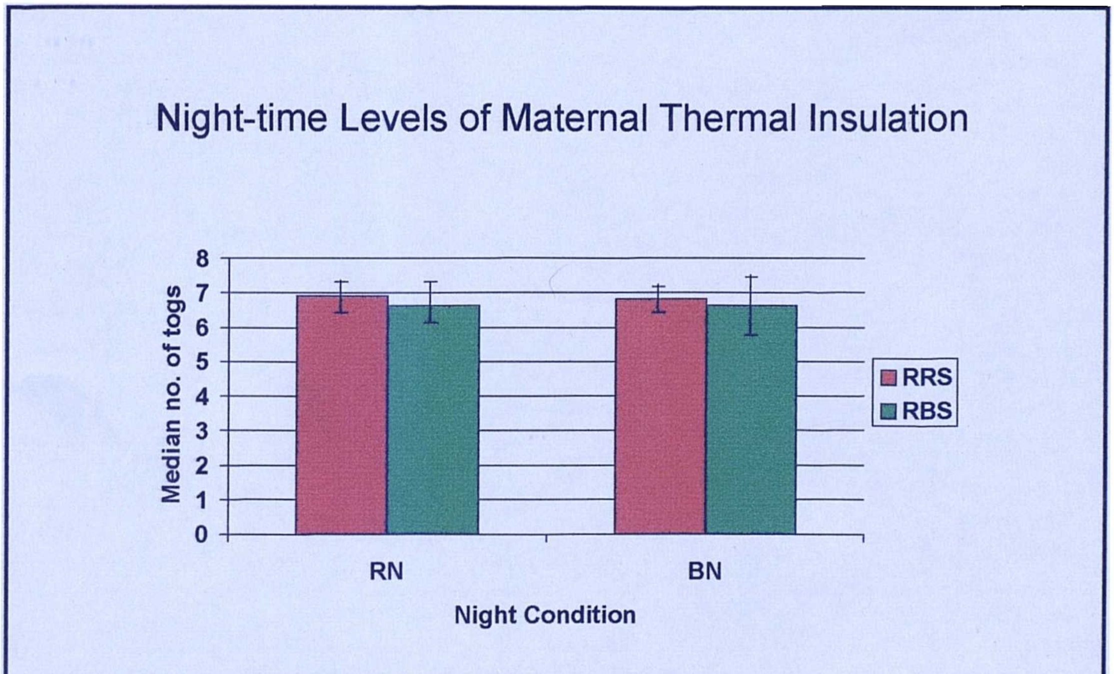
Table 7.19 Position of Bedding on Mothers' Body during the night			
IQ range = interquartile range		*Group*	
	Night Condition	RRS	RBS
Median % (IQ range) night bedding at Level 1	RN	45% (13-59%)	21% (6-52%)
	BN	33% (11-49%)	33% (7-71%)
Median % (IQ range) night bedding at Level 2	RN	40% (14-60%)	16% (8-65%)
	BN	45% (38-73%)	38% (9-55%)
Median % (IQ range) night bedding at Level 3	RN	10% (0-9%)	6% (3-28%)
	BN	2% (0-10%)	20% (12-36%)
Median % (IQ range) night bedding at Level 4	RN	0% (0-1%)	0% (0-3%)
	BN	0% (0-0%)	2% (0-6%)
Median % (IQ range) night bedding at Level 5	RN	3% (1-10%)	4% (1-7%)
	BN	1% (0-4%)	0% (0-2%)
Median % (IQ range) night bedding at Level 6	RN	0% (0-0%)	0% (0-0%)
	BN	0% (0-0%)	0% (0-0%)

Key: Level 1 Trunk to shoulder level (neck) with both arms covered
Level 2 Trunk to shoulder level with one or both arms uncovered
Level 3 Trunk to midchest (epigastric) level
Level 4 Trunk to level of hips
Level 5 Body completely uncovered by bedding
Level 6 Head and body completely covered by bedding

RRS on RN (n=105 hours) and BN (n=105 hours); RBS on RN (n=30 hours) and BN (n=30 hours)

Mothers were more likely to arrange bedding at the level of their shoulders with one or both arms free when bed-sharing, and at the level of their shoulders with both arms covered when sleeping separately from their infant. This observation was supported by tog units calculated for each subgroup of mothers. The median level of insulation as indicated by number of togs was very similar for both groups of mothers, although slightly lower for Routine Bed-Sharing mothers compared to Routine Room-Sharing mothers on both night conditions, and on bed-sharing nights compared to room-sharing nights for Routine Room-Sharing mothers. For Routine Room-Sharing mothers when comparing both night conditions, the difference in thermal insulation did not reach significance, however was in the direction of less insulation on bed-sharing nights compared to room-sharing nights (p=0.08). This finding is consistent with the observation that mothers in this sample tended to place their own bedding at lower levels on their body when bed-sharing with their babies compared to room-sharing nights when they slept alone, resulting in a lower thermal insulation value as less body surface area was covered. Figure 7.14 presents the levels of thermal insulation covering mothers at night.

Figure 7.14 Night-time Levels of Maternal Thermal Insulation



Bars represent medians, vertical lines represent interquartile ranges

Mothers rarely became uncovered by bedding during the night, and when they did they were almost always awake [median of 100% of night for all four subgroups]. Mothers in both groups and on both nights were observed to check room temperature on occasion, and others checked baby temperature by feeling the baby's forehead or chest, and then modified bedding arrangements.

Bedding data were also examined for age and season related trends to determine if mothers altered the amount of bedding placed on infants depending on the infant age or the month of the year, despite the temperature of the laboratory remaining constant. These trends were only examined in the Routine Room-Sharing group as the sample size for the Routine Bed-Sharing group was considered too small to make valid conclusions. No age related trends in thermal insulation levels were identified in the Routine Room-

Sharing group when comparing infants at ages 2-3 months with infants of 4-5 months, on room-sharing (p=0.7) or bed-sharing nights (p=0.2). Nor were any season related trends found in levels of insulation used for infants in the Routine Room-Sharing group when comparing summer with winter months on room-sharing (p=0.8) or bed-sharing nights (p=0.6).

The data set for the Routine Room-Sharing group was considered too small to separate out data points for age and season separately, as the sample size was composed of only 5 infants at four different time points. When considering infant age related effects, the possibility of the season of the year having an effect cannot be discounted; i.e. if mothers placed less bedding on infants as they become older, this may have been counterbalanced in this study by mothers placing more bedding on their infants as the months progressed towards winter and it became colder. It is therefore possible that if there were age or season related trends in bedding use, they may have cancelled each other out in this study. To address this possibility, the amount of bedding used by Routine Room-Sharing mothers was examined for season related trends, as maternal age was not considered to be an important factor for mothers in terms of levels of insulation used. Maternal thermal insulation was used as a proxy measure for amounts of insulation mothers may have used on their infants in response to season related trends in bedding use. No significant differences were found in the levels of insulation used by these mothers when comparing summer and winter months for both room-sharing (p=0.6) and bed-sharing nights (p=0.6). Although not conclusive as the sample size was too small, these findings suggest that there does not appear to be a season related nor age related trend in thermal insulation used by mothers for their infants in this sample of mother-infant pairs.

Part IV

Discussion

Chapter 8

Discussion

This investigation aimed to define and quantify the behavioural and physiological differences between breastfeeding infants who either routinely bed-shared or room-shared in the home environment. These preliminary studies are the second in-laboratory investigations of infant sleep in the context of parent-infant co-sleeping, and the first to investigate differences between routinely bed-sharing and room-sharing mother-infant pairs.

This was clearly a small, observational study in which many comparisons have been made. Significance has been assumed at the more extreme level of 1% instead of the standard 5% level, but interpretation of the results must still be viewed with caution. No firm conclusions can be drawn about the specific effects of bed-sharing from this small sample and simplistic analysis. The significance of any statistical tests should be treated as markers for areas of future study rather than 'real' findings. This discussion is intended to illustrate the kinds of important issues that can be raised by acknowledging the bed-sharing environment.

Observations of the repeated visits to the sleep laboratory, maternal self reports, and the home sleep diaries which mothers completed, all suggested that the behaviour and the sleep which was recorded in the laboratory was similar to that at home. This indicated that there was little 'first night' effect (Bernstein et al., 1973; McKenna et al., 1994) and that valid and complex behavioural and physiological recordings can be made of mothers and infants in experimental conditions resembling the home situation.

The author acknowledges that McKenna and Mosko's group were the first to document the unfolding sleep patterns of mothers and infants sleeping in physical contact (McKenna et al., 1990; 1993; 1994; McKenna and Mosko, 1994; Mosko et al., 1993; 1996; 1997a; 1997b; 1997c; Richard et al., 1996). However several important differences in this study's design make it more reflective of current British practice. The most common infant care strategy employed by parents, practiced by two fifths of the population, is to room-share with their infants, compared to a quarter of infants which are placed to sleep in a separate room (Blair et al., in press; Fleming et al., in press).

In the laboratory studies conducted by McKenna and colleagues, the use of a single bed for the bed-sharing nights and a separate room for the solitary nights, together with extensive monitoring of the mothers, served to accentuate the differences between the two conditions, making it more difficult for mothers to respond to their infants on solitary nights, and forcing close contact on the bed-sharing nights. In this study the use of a double bed, a lack of monitoring of the mother, and the use of the same room, minimised potential differences between the two night conditions under investigation.

Results

Important findings from this present study, under which more specific findings and their potential significance can be discussed, are that bed-sharing mothers and infants demonstrate a considerable degree of concordance in their sleep/wake states and a higher frequency of night-time interactions, which both appear to be partner induced. Observations indicate that mothers are sensitive to their infant's sleep state, and that bed-sharing exerts immediate effects on maternal and infant sleep that cannot be attributed to a simple novelty effect of the non-routine environment. Unfortunately, with the exception of the bed-sharing and solitary sleep studies conducted by McKenna and his team, little is known about mutual arousals in co-sleeping environments as arousal phenomena in the laboratory have only been studied among infants sleeping alone in a cot (McKenna et al., 1994).

Previous reports have indicated that infant apnoeas, thought by some researchers to be involved in the aetiology of SIDS, are more frequent in REM or active sleep (Guilleminault et al., 1979; Kahn et al., 1992; Mosko et al., 1996). The observation that bed-sharing mothers are more often awake when their infants are in REM sleep, suggests that these mothers may have a greater opportunity to detect potentially deleterious changes in their infant's status and respond accordingly in ways which may be protective against SIDS or other arousal deficiencies.

McKenna and colleagues have also reported that bed-sharing infants spend more time, at the same time, in the same sleep stage or awake condition as their mother (McKenna et al., 1990; McKenna and Mosko, 1994). In addition, they reported that babies also exhibit more frequent sleep stage shifts or awaken more frequently while bed-sharing. In this study the period of time infants spent awake appeared to be more related to routine sleep condition than condition on the night, with Routinely Bed-Sharing babies spending more time awake on both night conditions compared to Routine Room-Sharing babies. However night condition did seem to have some effect. Routine Bed-Sharing infants on room-sharing nights spent the most time awake, probably due to the unfamiliar condition of being separated from their mother, and appeared to find settling to sleep more difficult. Interestingly, Routine Room-Sharing infants spent the least time awake on bed-sharing nights of the four subgroups.

McKenna and colleagues also reported that bed-sharing infants spend less time in deep stages of sleep (stages 3 or 4), this state being associated with a greater arousal threshold; and more time in light sleep (stages 1 and 2) (McKenna et al., 1990; Mosko et al., 1996). Due to the need for consistency and the wide age range of studies (from one to five months of age) in this investigation, only active and quiet sleep were categorised with no sub-division of quiet sleep, as this cannot be reliably performed in infants of 2 months or less. This investigation was therefore limited in being able to compare infant sleep state findings with those of McKenna and colleagues (McKenna et al., 1993; Mosko et al., 1996; 1997a). However the findings reported by McKenna, Mosko et al. (1990; 1993) are potentially important if arousals are acknowledged as protective responses required of the infant to terminate life-threatening events or hypoxaemic episodes. These researchers suggest that it is more difficult for infants to arouse to terminate these life threatening events and reinitiate breathing from deep stages of sleep, than it is for them to arouse from lighter stages. They propose that solitary infant sleep environments may accelerate the maturation of deep sleep in infants prematurely, before arousal mechanisms are able to cope effectively, and that this problem may be exacerbated in infants born with arousal deficiencies or those who may experience physiological crises (McKenna et al., 1993; McKenna, 1996a). They further hypothesise that partner-induced arousals which occur during bed-sharing may act to compensate for deficient, internally controlled arousals in the infant, when and if they are needed (McKenna and Mosko, 1990).

Infants in all of the defined subgroups produced similar numbers of movements and noises during the night, but the percentage of baby movements or noises which initiated an interaction by stimulating a response by their mother was greatest for Routine Bed-Sharing pairs on both nights, and on bed-sharing nights for both groups. This in turn led to a greater number of total interactions in Routine Bed-Sharing pairs on both nights compared to Routine Room-Sharing pairs, and on bed-sharing nights compared to room-sharing nights in both groups. Maternal responses to baby initiated interactions often appeared to prolong these infant arousals, and this observation is supported by the finding that Routine Bed-Sharing infants spent longer periods of time in movement and noise on both nights than Routine Room-Sharing infants. Given that most of the interactions which occurred during the night reflected instances in which the infant aroused first, these findings imply a high level of maternal responsivity on the mother's part to her infant, that did not habituate with routine bed-sharing, and indeed, routine bed-sharing may heighten maternal responsiveness. This evidence of maternal sensitisation to infant stimuli is consistent with the findings of Mosko et al. (1997b) in which co-sleeping mother-infant pairs exhibited overlapping arousals, many of which appeared to be partner induced. The fact that most of the infant initiated arousals included a noise, which could potentially have been heard by the mother when room-sharing or bed-sharing, supports this suggestion of heightened maternal responsiveness when bed-sharing. This is particularly interesting, considering that on room-sharing nights the baby in the crib was positioned very close to the mother, next to the side of the double bed.

Mothers from both groups were observed to respond to more baby-initiated interactions, than babies responded to mother-initiated interactions. This finding supports the view proposed by McKenna et al. (1990) that mothers generally appear to be the more sensitive partner in the co-sleeping dyad. These researchers suggest that this reflects an inability of the infant to monitor sensory cues as efficiently as the more mature partner (McKenna et al. 1990). However when babies did respond to an interaction initiated by their mother, they responded more quickly than mothers responded to babies regardless of night condition, which indicates that babies are generally extremely responsive to sensory stimuli within their environment.

Many SIDS researchers believe that arousal deficiency plays an important role in the aetiology of SIDS (Einspieler et al., 1988; 1994; Kahn et al., 1992; Kinney et al., 1995). If this is the case, manipulations or conditions in the infant's sleep environment that facilitate arousability might be protective against SIDS. Mosko and McKenna (McKenna et al., 1994; Mosko et al., 1997a) have also speculated that during the critical period when infants are vulnerable to SIDS, bed-sharing may ensure a 'basal' level of practice required for the integration or coordination of the neural mechanisms that underlie the arousal response. By this McKenna and colleagues are suggesting that bed-sharing, by increasing the type and number of arousals, could compensate for an arousal deficiency, possibly by providing an infant with more opportunities to practice arousing, thereby enabling it to become more proficient at it; or through closer proximity to its mother, permitting her to intervene should she see or hear a distress signal from her baby (McKenna, 1996a).

The finding that infant arousal, observed as movements and noises occurring during sleep, was greater even when room-sharing in Routine Bed-Sharing infants, than in infants who routinely room-shared, supports the notion that 'practice' has a sustained impact on arousability. In addition, the observation that response times to mother-infant interactions were reduced when bed-sharing, especially those responses in which mothers reacted to stimuli initiated by their infants, also suggests that bed-sharing may provide a sleep environment for infants in which maternal sensitivity and attentiveness are enhanced.

Another important finding in this study, similar to reports by McKenna and colleagues (McKenna et al., 1997), is that Routine Bed-Sharing infants breastfed twice as frequently as Routine Room-Sharing infants on both night conditions. In this study, these feeds were of a much shorter duration. The home sleep logs revealed that Routine Bed-Sharing pairs were also breastfeeding more often at night than Routine Room-Sharing pairs. This is further evidence that the laboratory findings are representative of behaviour in the home environment.

Although similar in many ways, there were some differences in breastfeeding behaviour identified in this group of mother-infant pairs when compared to the Latino mother-infant pairs studied by McKenna and colleagues. Firstly, although the median number of breastfeeds for Routine Bed-Sharing pairs was at least twice that of Routine Room-Sharing pairs on both night conditions, both groups of mothers and infants fed more frequently on their room-sharing nights compared to their bed-sharing nights. This finding contrasts with the observations of McKenna and colleagues (1997) who reported that, in their sample, the number of breastfeeding episodes was increased on bed-sharing nights for both groups of mothers, although they too found that Routine Bed-Sharing pairs fed more frequently on both night conditions than did mothers and infants who routinely slept separately. The increased frequency of breastfeeds on room-sharing nights in this investigation may be partially explained by the observation that Routinely Bed-Sharing mothers often appeared to experience difficulty in settling their infant in a cot on the non-routine room-sharing night, and used breastfeeding to calm a restless infant. In addition, the night condition appeared to have a strong effect on the frequency of breastfeeding in McKenna's sample, whilst in this study, routine condition appeared to have a greater effect than night condition.

McKenna et al. (1997) also reported that when comparing routine nights, their Routine Bed-Sharing pairs fed twice as frequently as Routine Room-Sharing pairs, and feeds were approximately 39% longer in duration, resulting in a total feed duration for the night which was almost three times as great. In this study however, although Routine Bed-Sharing pairs fed twice as frequently on both night conditions when compared to Routine Room-Sharing pairs, feeds were shorter in duration. In fact, the median feed duration for Routine Bed-Sharing pairs on bed-sharing nights was almost half that of Routine Room-Sharing pairs on room-sharing nights. Although the total feed duration for Routine Bed-Sharing pairs on bed-sharing nights was the greatest of the four subgroups it was not significantly different from Routine Room-Sharing pairs on room-sharing nights. It is possible that with a larger sample size, especially in the Routine Bed-Sharing group, this trend for the total feed duration to be longer when bed-sharing may have become significant. Frequent short feeds throughout the day and night have been reported in hunter-gatherer societies who traditionally bed-share and breastfeed into the second year of a child's life. In these cultures, infants have been observed to feed very frequently, up to several times per hour, and feeds are often only a couple of minutes in length (1.92 ± 0.18 minutes per feeding episode) (Konner and Worthman, 1980).

The opportunity to breastfeed quickly and conveniently, to use breastfeeding to calm a restless infant, or exposure of the infant, through close proximity to their mother, to olfactory and other sensory cues that might facilitate breastfeeding (Russell, 1976; Porter et al., 1983; Cernoch and Porter, 1985), are all factors that could explain the increased frequency of feeds in the bed-sharing environment, which in turn contributed to the greater concordance in sleep/wake states and increased frequency of mother-infant interactions. As McKenna and colleagues have speculated (McKenna et al., 1997), exposure to maternal odours during bed-sharing may lower the infant's arousal/hunger threshold. Another important point is raised by the observation that bed-sharing infants arouse more frequently, and with a far greater synchrony in arousals and sleep/wake patterns with mothers, observed in this study and by McKenna, in addition to having less stage 3 or 4 quiet sleep in which arousability is diminished (McKenna et al., 1993; Mosko et al., 1997a). One obvious short term benefit of having more frequent arousals is that infants have more opportunities to suckle during the night. As previously addressed in Chapter 3, human milk is low in fat and protein and high in carbohydrates, which are metabolised rapidly, which suggests that infants are adapted to frequent or 'continuous' feeding (Lozoff and Brittenham, 1979). McKenna (1995a) also proposes that it is possible that increased sucking and milk digestion which occurs when bed-sharing may in turn encourage more Stage 1-2 (light) sleep; a sleep state in which it is easier for an infant to arouse.

Bed-sharing may also promote breastfeeding by allowing mothers to sense their infant's more subtle noises and movements which increase in frequency and intensity as breastfeeding episodes are approached. For infants sleeping separately from their parents, crying is often the only way they can elicit maternal attention. The observation that mothers who were bed-sharing were more likely to respond to baby initiated interactions stimulated by movement only, probably due to the closer proximity, and that routinely bed-sharing babies rarely cried to attract maternal attention prior to eliciting breastfeeds, supports this hypothesis.

A protective effect from breastfeeding, identified in previous studies (Ford et al., 1993; Hoffman et al., 1988), has not been confirmed in more recent epidemiological studies examining risk factors for SIDS (Fleming et al., 1996; Mitchell et al., 1997; Fleming et al., in press). Despite this, the observation that bed-sharing promotes breastfeeding, also indicated by previous epidemiological and observational studies (Ford et al., 1994; Clements et al., 1997; McKenna et al., 1997), may have important implications for infant and maternal health. Apart from the many documented benefits of breastmilk as a species specific food for human infants (Garza et al., 1987; Henschel and Inch, 1996), studies have suggested that frequent nipple contact or sucking and relatively short intervals between breastfeeds are required to sustain high levels of circulating prolactin which are known to suppress ovulation, increase birth interval and thus limit maternal fecundity (Konner and Worthman, 1980; Howie and McNeilly, 1982; Vitzthum, 1994b; Ellison, 1995). In addition, prolactin release in response to night time suckling is greater than during the day; thus milk production may get its greatest 'boost' when the baby feeds at night (Glasier et al., 1984; Royal College of Midwives, 1991). It is therefore reasonable to speculate that breastfeeding, bed-sharing mothers may become pregnant later, providing their infants with the opportunity to benefit longer from less divided maternal attention and resource allocation, thereby improving both maternal and infant prospects of better physical and psychosocial health (Lozoff and Brittenham, 1979; Konner and Worthman, 1980; McKenna et al., 1997).

Epidemiological studies conducted in the United Kingdom and in New Zealand provide evidence which indicates that bed-sharing is associated with a longer duration of breastfeeding (Ford et al., 1994; Clements et al., 1997). It is therefore reasonable to suggest that the increased daily infusion of maternal antibodies over a longer period of time for breastfeeding, bed-sharing pairs, especially in the first six months when their own immunological systems are least efficient, may provide these babies with increased protection from infectious diseases, some potentially related to SIDS (McKenna et al., 1997). Arnon (1983) suggests that breastfeeding has a role in protecting against infant botulism, which may be misdiagnosed as SIDS up to 5% of the time. McKenna et al. (1997) also hypothesise that bacterial infections which possibly interact with a range of infantile deficits to cause some SIDS deaths, may be reduced by the increased breastfeeding associated with bed-sharing.

Epidemiological studies record habitual sleeping position in terms of how an infant is put down to sleep and in what position they were found, while some studies may even record these data for a particular night. However these studies do not record what changes in position occur during the sleep, if any, partly because the parents are not able to record what happened. This study is one of the first to examine the whole duration of night-time sleep for the infant. An important finding from this study is that mothers from both groups rarely positioned their infants prone at any time during the sleep. This is an important observation as prone sleeping has been found to be a significant risk factor for SIDS in almost all the studies in which it has been investigated (Gilbert, 1994; Fleming et al., 1996; Mitchell et al., 1997). Mothers were observed to place their infants prone only while settling them to sleep, before repositioning them supine in the cot or bed, and were therefore almost always awake while their infants were prone. Infants were also always in direct physical contact with their mothers while positioned prone. These observations suggest that mothers were aware that babies should not be left unattended in the prone position.

Side sleeping has also been identified as an independent risk factor for Sudden Infant Death Syndrome (Fleming et al., 1996; Mitchell et al., 1997). Although infants who routinely bed-shared were more likely to be observed side-lying than Routinely Room-Sharing infants on both night conditions, this finding is partly explained by the observation that Routine Bed-Sharing mothers were more likely to breastfeed their infant whilst lying down, with both parties positioned on their sides, ventrum to ventrum. Routine Room-Sharing mothers, especially on room-sharing nights, were more likely to sit up to feed their baby. Routine Bed-Sharing infants also breastfed twice as frequently as Routine Room-Sharing pairs on both night conditions (Young et al., 1998) which may have contributed to the greater time Routine Bed-Sharing infants spent side-lying. Much of the increased risk of side sleeping is related to the risk of the baby placed to sleep on the side, rolling into the prone position (Hassall, 1985; Fleming and Blair, 1997). In this study infants were never observed to roll prone during or after a feed, possibly due to their mother's body which supported them in the side-lying position and presented a physical barrier which prevented babies from rolling forward onto their fronts. Mothers were also often awake for at least part of the breastfeed, and therefore had the opportunity to reposition infants supine during or after feeds. After a feed in bed, infants were observed to remain side-lying in close contact with their mother; be repositioned supine by their mothers, or rolled back into the supine position themselves. Maternal sleep position was also documented using the behavioural code in this study, however results from these analyses were only reported in terms of the physical orientation mothers adopted in relation to their infants during the night.

The observation that infants initiated most of the interactions which occurred during the night, and more interactions occurred while bed-sharing, supports McKenna's view that infants are active participants in their own care in the co-sleeping environment (McKenna et al., 1994). A baby would not be able to feed very easily, if at all, while lying prone. In addition, it appears that the supine position allows infants to assert more control over their environment. Movement of limbs is especially facilitated in this position, so infants can more easily make their needs known by kicking off bedding or eliciting maternal attention (McKenna et al., 1994; Richard et al., 1996). Supine-sleeping infants have also been shown to experience twice as much motor activity during sleep, shorter sleep durations, and increases in the number and duration of arousals and awakenings compared to prone-sleeping newborns (Douthitt and Brackbill, 1972; Kahn et al., 1993). As the goal of parents and health professionals has been to promote sleep and not awakenings, these data provided an argument for why infants should sleep prone (McKenna, 1995a). However now that the risks of prone sleeping have been recognised it has been hypothesised, but not proven, that some infants who die of SIDS cannot arouse to reinitiate breathing; that is they sleep too deeply, before sufficiently mature arousal mechanisms in the brain are developed (McKenna, 1995a; Takeda, 1987). The supine position may be safer because of the increased arousal and motor activity associated with it.

In all but a limited number of cultures worldwide, breastfeeding and co-sleeping are practiced as one integrated care system (Barry and Paxson, 1971; McKenna et al., 1994), and even in Western societies, bed-sharing and breastfeeding are closely associated (Ford et al., 1994; Clements et al., 1997). In these cultures where bed-sharing is common, placing infants on their backs to sleep is the norm (Davies, 1994). McKenna, Richard and colleagues suggest that the supine position is the more universal or 'species wide' preferred position, and that it is therefore not surprising that it is safer than the prone position when considering the risk of SIDS (Richard et al., 1996). Although the mothers in this sample were predominantly middle class and well educated, and therefore probably aware of current advice with regards to infant sleep position as the study was conducted after the 'Back to Sleep' campaign in 1991, it is possible that a mother's choice of infant sleep position may be partly due to sleeping arrangement and the ease of breastfeeding in non-prone positions. If bed-sharing and breastfeeding do contribute to the mother's choice of non-prone infant positions, these practices could be viewed as providing an environment which is beneficial to the infant, at least in terms of minimising the high risk prone position.

The analysis of infant sleep position in this investigation included periods spent breastfeeding in which infants and mothers were often awake for at least part of the time, which limits the interpretation of these findings. Further analysis of infant sleep position in which all awake time was excluded, as in Richard et al. (1996), may give a more accurate assessment of the time infants spent in each of the three sleep positions, and would almost definitely reveal that Routine Bed-Sharing infants spend much less time in the side lying position than the primary analysis first indicated.

Heavy wrapping and soft bedding have been identified as risk factors for SIDS (Fleming et al., 1990; Ponsonby et al., 1993; Kemp et al., 1993; 1998; Wilson et al., 1994; Williams et al 1996), however recent studies have shown these factors to be of less importance in populations in which few infants sleep prone (Kemp et al., 1994; Fleming et al., 1996; Fleming and Blair, 1997). Differences in general clothing and textile practices (e.g. bedding items, swaddling, mattress type and room heating) have also been identified and are likely to be influenced by factors such as education, ethnicity, season and geographic location (Nelson and Taylor, 1988; Wilson et al., 1994).

Mothers who routinely bed-shared were more likely to use an adult duvet to cover their infants when bed-sharing. Bedcovers such as duvets or crib quilts, which can easily slip over the baby's head, especially when the infant is sleeping prone (Fleming et al., 1996; Sawczenko and Fleming, 1996), carry a very high odds ratio for SIDS (21.58, 95% CI 6.21, 74.99). Infants were rarely observed to become completely covered by bedding and never when bed-sharing with their mothers in the paired night analysis. On one room-sharing night a Routine Room-Sharing mother 'swaddled' her infant so as to cover the infant's face with a layer of cellular blanket. The CO_2 level was observed to rise briefly to 2.4%. These findings were consistent with reports from the CESDI SUDI study which suggested that prone positioning and head covering were much rarer events when bed-sharing. The risk associated with these 'high risk' factors were predominantly in the cot environment (Blair et al., in press). Another important observation made in this investigation was that at no time was any mother observed to roll on her infant, even when sleeping very close together. This observation is supportive of the hypothesis that mothers are extremely sensitive to infant cues and environmental conditions when co-sleeping (McKenna, 1998).

Some mothers were also observed to place infants on, rather than in, the parental bed. In one New Zealand study the Pacific Islanders had the highest rate of bed-sharing (42.2%) and the lowest SIDS rates (Tuohy et al., 1993), and were noted to place infants on, rather than in, the parental bed. This subtle difference in behaviour requires further investigation. Perhaps this practice prevents infants from becoming completely covered by bedding; or maybe the traditional bedding used by this population is not typical of Western style blankets, duvets and pillows, or perhaps the Pacific Islanders arrange similar bedding differently ? For as Byard (1994) argues

> '...sleeping several feet above a floor on a soft mattress covered by layers of synthetic material does not necessarily replicate traditional tribal or animal behaviour' (Byard, 1994, p. 199).

One could speculate that the slow increase in SIDS rates within the Pacific Islander population, contributed to by the increasing number of young women who are beginning to smoke (Davies, 1994), may also reflect the adoption of more Western cultural practices, for example the use of duvets and soft mattresses (Byard, 1994), in place of traditional bedding.

On both night conditions in both groups, infant bedding was most commonly placed by mothers at the level of the infant's shoulders with one or both arms free. This practice, together with the supine position, appeared to give the infant greater control over their environment; e.g. bedding could be moved away using the hands or kicked off, and the use of the head, arms and legs by the infant to communicate their needs to their mothers is facilitated in the supine position (McKenna, 1995a). When bed-sharing with their babies, mothers more commonly placed bedding so the highest level was secured under their own armpit, and thus prevented it from moving up over their shoulders during sleep. When sleeping alone, mothers more frequently positioned bedding so that both arms and shoulders were covered. This difference in practicc when bed-sharing potentially reduces the chances of an infant who is sleeping face-to-face in close proximity, becoming completely covered by bedding, and indicates that mothers are aware of avoiding such situations in which an infant's head may become covered.

While bed-sharing, mothers, and particularly infants, spent the majority of the night orientated towards their partner, and were often face-to-face, less than 20 cm apart, and spent more time during the night in direct physical contact with each other. A common orientation was the mother on her side facing the infant, and the infant on their side or back facing the mother near breast level. Several studies have suggested that olfactory stimuli including breast (MacFarlane, 1975) and axillary odours (Cernoch and Porter, 1985) can account for some of the infant's orientation towards its mother. The infant's closer proximity to the mother's breast may enhance the infant's exposure to sensory stimuli, including olfactory cues, from the mother which may facilitate breastfeeding. This hypothesis is supported by the observation that routinely bed-sharing pairs breastfed twice as frequently as routine room-sharers. In addition, close face-to-face proximity and direct contact may generate other sensory stimuli by the mother breathing onto the infant's face and head, including CO_2, tactile, olfactory, auditory and thermal stimuli, which may potentially induce arousals and influence infant sleep state and respiratory patterns (Galland et al., 1993; Mosko et al., 1995; Stewart and Stewart, 1991).

As carbon dioxide can stimulate respiration and arousal, the mother's proximity to the infant warrants investigation as a potentially important factor in susceptibility to SIDS (Kinney et al., 1995; Richard et al., 1996). Some researchers have also expressed concern about the possible effects of CO_2 rebreathing by infants sleeping close to their mothers, as there has been some evidence that accumulation of lethal levels of CO_2 in bedding might contribute to some cases of SIDS (Chiodini and Thach, 1993; Kemp et al., 1994). In response to these research questions, particular emphasis was placed upon recordings of tidal CO_2 during the bed-sharing nights in this investigation. These recordings were part of the physiological investigations undertaken as part of the larger study and have been described in detail elsewhere (Sawczenko et al., 1995; in press). Baseline inspired CO_2 levels were similar for both room-sharing and bed-sharing nights varying between 0.3% to 0.6%. On some bed-sharing nights levels rose from 0.6% to 0.9% briefly, and reverted to lower levels with movements of the baby, duvet or mother. On only three occasions were levels observed to rise above 0.9%, to a maximum inspired CO_2 level of 2.4%, and involved both room-sharing and bed-sharing nights. These occasions were brief and involved an infant's respiratory passages being covered in some way, either by bedding or by direct maternal contact. During such periods of raised inspired CO_2, respiratory excursions increased and oxygen saturation remained 95% or greater (Sawczenko et al., in press). These findings are comparable with Richard et al. (1996) who reported peak expiratory CO_2 levels in air at various distances from women's nares ranging from 2.36% at 3 cm to 0.34% at 21 cm. This research team later reported (Mosko et al., 1997c) that peak CO_2 concentrations averaged 2.36% at 3 cm; remained above 1% at 9 cm, was approximately 0.5% at a distance as great as 18 cm, and was still about eight times room air at 21 cm, when mother-infant pairs slept in face-to-face orientations. Both baseline and peak CO_2 levels were further increased at all distances when measured within a partial air pocket created to simulate a bedding environment, sometimes seen during bed-sharing (Mosko et al. 1997c).

Mosko and colleagues (1997c) concluded that, during bed-sharing, there was a potential for a high degree of close proximity and face-to-face orientation, and consequently increased environmental CO_2 to non-lethal levels as a result of maternal respiration. McKenna, Mosko and colleagues (McKenna 1995a; Mosko et al., 1997c) suggest that these CO_2 levels are within a range that could potentially increase ventilation in young infants, according to steady state breathing studies (Schafer et al., 1993). In addition, Mosko et al. (1997c) suggest that because both mothers and infants arouse more frequently during bed-sharing, associated body movements should act to aerate the bedding and prevent excessive CO_2 accumulation; a hypothesis supported by the results of our investigation.

In this investigation, proximity measures were grouped into three categories: i) less than 20 cm; ii) between 20-60 cm; and iii) over 60 cm, to represent i) within a baby's arm reach, ii) within a mother's arm reach, and iii) beyond a mother's arm reach, respectively. Median head and body distances demonstrated by Routine Bed-Sharing and Routine Room-Sharing pairs were essentially the same when comparing the two groups for each of the night conditions. By employing this scale however, it is possible that subtle differences between Routine Bed-Sharing and Routine Room-Sharing pairs when bed-sharing may have been overlooked. For example, a Routine Bed-Sharing pair may have been more likely to sleep less than 30 cm apart, while a Routine Room-Sharing pair may have slept over 40 cm apart. Using this scale both mother-baby pairs would have been allocated to the category of sleeping between 20-60cm apart when bed-sharing. Future studies with simple modifications to the existing behavioural code could examine proximity in further detail.

Stewart and Stewart (1991) have proposed that as infants are able to process and respond to environmental stimulation in sleep, appropriate external stimuli might compensate for a respiratory control defect. Using an animal model they reported that presentation of repetitive auditory stimuli could influence respiratory rate in infants. McKenna and colleagues (1993) raise the question of whether breathing sounds or even respiratory movements of a co-sleeping parent could provide compensatory respiratory stimulation for some infants with defective respiratory controls. McKenna (1993) even suggests that the baby monitor, designed to allow parents to monitor the infant, should be used in reverse, or should at least broadcast sound in both directions. Infants sleeping separately from their parents could then process adult stirrings, especially breathing sounds and vocalisations. Infant sleep, heart rate, breathing and arousal levels are all affected by such stimuli, probably in adaptive ways to facilitate development and to maximise adjustment to environmental perturbations (McKenna, 1993).

Vestibular stimulation of neonates and premature infants has been shown to reduce crying and the number of apnoeas experienced during sleep (Korner and Thoman, 1972). Thoman (1986) also reports on the success in stabilising breathing patterns of high risk infants by placing in their cribs mechanically breathing teddy bears that provide a constant source of the rhythmic vestibular stimulus that most closely resembles the parent's chest.

As previously discussed, some investigators have suggested that an arousal deficiency may manifest as SIDS in some infants (Sterman and Hodgman, 1988; Kahn et al., 1992). If this is the case, this study's findings that bed-sharing appears to induce more frequent feeding arousals and interactions, most probably due to a continuous sensory exchange facilitated by the close proximity between bed-sharing pairs, is potentially important, especially as arousal constitutes a stimulus for breathing (Sterman and Hodgman, 1988). In addition, the mother's enhanced arousals, together with her proximity to the infant, increase the likelihood of her detecting when caregiver interventions are needed and taking appropriate action.

During night-time mother-infant interactions, mothers in both groups were observed to communicate with their babies through touch, rather than using verbal communication. With regard to vocalisation behaviour, mothers appeared to behave differently during the night than they did when observed during the early evening prior to settling their infants to sleep. Verbal communication by mothers to their infants which did occur during the night was predominantly in whispered tones. Mothers appeared to be trying to minimise the stimuli during nocturnal interactions. It is possible that these were maternal attempts to minimise the duration of these interactions so that both mother and baby could return to sleep, and therefore indicate to the infants that night-time was different from day-time. Such behaviour is not easily quantifiable. The results reported in this investigation included an analyses of the frequency and duration of movements and noise produced by mothers. In addition, analyses were conducted to determine what proportion of movements were accompanied by noise for both mother and infant. However these analyses included noises which mothers made in their sleep and which may or may not have been directed towards their infant. Although time consuming, it would be possible using the behavioural code which also noted verbal communication during the night, to assess each mother-infant interaction for the presence of maternal vocalisation directed towards the infant. In future studies, observational data relating to day-time interactions between mothers and infants, and some measure to grade vocalisations (e.g. 'whisper', 'normal talking', 'raised voice') or quantify loudness in terms of decibels, may be useful in determining differences in verbal behaviour between mothers and their infants during the day and night.

Several researchers have postulated an important role for environmental and core temperature in SIDS through their powerful impacts on sleep architecture, arousal and respiration. Deviations from thermoneutrality might lead to SIDS through a variety of mechanisms (Fleming et al., 1990), therefore speculation about a possible thermoregulatory effect of bed-sharing is warranted (Mosko et al., 1993). In this study, median levels of insulation were higher on bed-sharing nights for both Routine Room-Sharing and Routine Bed-Sharing babies, and highest for Routine Bed-Sharing babies whose mothers were more likely to use the adult duvet to cover the infant. The physiological component of the larger study addressed the impact of bed-sharing on the infant's thermal environment. Despite differences in thermal environment and evidence of active heat excretion (higher peripheral temperatures) in infants aged 2-5 months, rectal temperature was maintained or slightly lower when bed-sharing, which suggests effective thermoregulation (Sawczenko et al., in press).

Bed-sharing provides immediate proximity which enhances the mother's opportunity to experience the environment personally and make adjustments if the infant's sleep environment becomes too hot or too cold. This hypothesis is supported by the observation that many mothers in the study were observed to check baby temperature by feeling the baby's forehead or chest and then modified bedding arrangements, often in response to a baby's arousal. Even during very short arousals, mothers very often stroke or pat the head, back or chest of their infant, gestures which would allow her to sense if the infant was too hot or too cold, behaviours also observed by McKenna, Mosko and colleagues (Mosko et al., 1993). Further evidence suggesting that mothers are extremely aware of their baby's environment during the night comes from the observation that no babies were observed to become completely covered by bedding on their bed-sharing night in the paired night analysis. In addition, two recent studies have recently established that while touch may overestimate the incidence of fever, with touch, fever will rarely be missed (Einterz and Bates, 1997; Whybrew et al., 1998). Community studies have also shown that parents instinctively provide appropriate conditions for their babies to sleep in (Wigfield et al., 1993).

In the bed-sharing environment, infants were almost always supine and mothers were more frequently observed to lean over and inspect their infant during the night. During these episodes, mothers would often reposition their infant and/or their bedding, and stroke, touch or whisper to their babies. McKenna and colleagues (McKenna et al., 1994) have reported similar maternal behaviour in their group of Latino mother-infant pairs. It is reasonable to speculate, as does McKenna (1995a), that these episodes increase the likelihood of a mother discovering and intervening to reverse a potentially dangerous condition or situation. In addition these activities appear to induce arousals at times when there would have been no arousal had the infant been sleeping alone (McKenna, 1995a).

Sources of bias

There are several potential sources of bias which must be considered when interpreting the results from any study.

Measurement Bias

The technique of measuring variables must be reliable if true differences are to be found (Burns and Grove, 1993). The repeated measures from observations of mother-infant pairs have been treated as independent data points which could produce bias, especially if the measurements of one mother-infant pair are consistently extreme in the same direction. Researchers undertaking similar studies based on longitudinal designs in future would need to consider these methodological and analytical problems and employ more complex statistical techniques, including linear mixed effects models, which account for the correlation between repeated measurements made on the same mother-infant pair. In addition, not only are repeated measures used at each age point, but the crossover design which was employed at each of these points may also have extended the possibility of bias. Further variation at the observational level suggests that analysis must account for variation on at least three levels, as discussed in Chapter 5. In this study, the longitudinal design allowed the investigation of infant care practices which may have changed over time as the infant became older. Very few age related differences were found, so data were pooled and repeated measures were used from the same mother-baby pair.

Selection Bias

Ideally the selection of subjects should be based on a randomised system to provide results which could be generalised to the whole population (Altman, 1991). Due to the level of commitment necessary to complete this longitudinal study, and the intention to observe mother-infant pairs with particular infant care practices, i.e. room-sharing and bed-sharing, purposive sampling was employed to increase the understanding of infant care practices not easily examined using other sampling techniques. With regard to the selection of subjects, this study was therefore biased in several ways; briefly discussed in Chapter 5. Mothers were self-motivated to participate in the study, which cannot be controlled for, especially given the intrusive nature of the study and the level of commitment required to complete the five month study period. Mothers and babies were also of low risk for SIDS, but this was an objective of recruitment. Findings from this investigation cannot therefore be generalised to high risk groups or the wider population.

Routine Bed-Sharing mothers were slightly older than Routine Room-Sharing mothers, and three of the five mothers each had several other children. It is possible that the differences observed between groups for the effects of night condition may have been influenced by age and/or previous infant care experience rather than night condition alone. In addition, subject knowledge of a study may potentially influence their behaviour and possibly alter the outcome of a study (Burns and Grove, 1993). It is possible that mothers from both groups who participated in this study may have behaved differently, e.g. more responsive to their baby, simply because they were part of a study and aware that they were being observed. A study's design validity may also be threatened by 'hypothesis guessing', in which subjects may change their behaviour based on what they think the researchers want them to do, as opposed to exposure to a treatment, or in this case, night condition (Burns and Grove, 1993).

This study attempted to control for these problems by asking parents to complete home sleep logs, which showed that sleep and infant feeding patterns at home were very similar to those observed in the sleep laboratory. Home sleep logs which detailed information about the infant's home sleep environment, including night-time feeding and waking patterns, confirmed the inclusion criteria and the eligibility of each mother-infant pair to be included in their allocated group. All Routine Bed-Sharing pairs bed-shared for 7 nights per week, for at least 6 hours per night. All Routine Room-Sharing pairs predominantly room-shared each night, bed-sharing for a median of only one night per week for no more than 2-4 hours per night. In addition, parents participating in the study were blind to all experimental hypotheses and given only a simple explanation of the study which did not include the outcome expected from the treatment condition. Parents were also unaware that they had been assigned to a particular group on the basis of their parent-infant bed-sharing behaviours.

Recall Bias

Previous investigations of night-time infant care practices have been almost exclusively limited to questionnaire and interview based studies, which are reliant upon parental recall. What one cannot do in these studies is check the accuracy of the information given by the parents after the event or night in question. The effects of recall bias were minimised in this study by the use of video recordings which served as a direct measurement tool and permanent record of the night-time behaviour and interactions between mother-infant pairs. Neither mothers, nor the researcher, needed to recall events during the night as video data could be directly checked for the occurrence of an event during analysis. Home sleep logs were subject to some recall bias by mothers of the events during the previous night. Previous studies have shown that mothers often significantly underestimate the frequency of breastfeeds, while consistently overestimating duration, compared to the researcher's direct observations (Vitzthum, 1994a). To minimise this potential bias in the home sleep logs, mothers were encouraged to keep a bed-side record of feeds which occurred during the night, and to complete the home log as soon as possible on waking that day.

Interviewer Bias

The expectancies of the researcher can bias the data and the technique of measuring variables must be reliable if true differences are to be found (Burns and Grove, 1993). The majority of video recordings were coded by the author, however due to time constraints, a second individual assisted with some data coding and subsequent analysis. To ensure consistency in the approach, coding and documentation of mother-infant behaviours by the two individuals, several steps were taken as discussed previously in Chapter 5. Several studies were coded together, to familiarise the assistant with the code and method of documentation. The assistant then coded several studies alone, and one which had already been coded by the author. The author and assistant met to discuss any problems and discrepancies which had arisen. Discrepancies were rechecked and mutually agreed upon after re-examination of the original video data. Regular meetings were held between the researcher and the assistant throughout the period of video analysis to discuss queries. Intra- and inter-observer reliability checking was performed using a convergence design at the end of the period of coding to determine the degree of consistency within, and between, individuals using the behavioural code. The reliability checking which was performed showed very little difference in how a study was coded originally and how it was recoded.

Data Quality and Reliability of Information

The behavioural data which was collected during this study was reliant on the video and audio recording system established within the sleep laboratory and where the mother-baby pair was positioned in relation to the accessible visual field. On rare occasions, in which the view of the baby or mother was obscured for short periods, usually by bedding on both room-sharing and bed-sharing nights, documentation or exclusion of variables were performed using the criteria outlined in Chapter 5. For future studies, especially those based in the community, additional cameras positioned at various points in the room may facilitate visualisation of the mother-baby pair at all times, even under difficult conditions.

<u>Summary</u>

In our investigation of night-time behaviour between mother-infant pairs of low SIDS risk, no adverse effects of bed-sharing were observed. Bed-sharing mother-infant pairs commonly slept face-to-face, in close proximity and often in physical contact. This high degree of mutual orientation would increase the magnitude and variety of sensory stimuli the infant was exposed to and appears to affect maternal and infant behaviour in ways which indicate that each member of the pair retains a great deal of awareness of the other partner's presence. The enhanced maternal responsivity to infant cues which is evident when bed-sharing is evidence against the popular view that bed-sharing carries a significant risk of overlaying and accidental suffocation.

Epidemiological studies have suggested that the practice of parents room-sharing with their infants reduces the risk of SIDS (Scragg et al., 1996; Mitchell et al., 1997; Blair et al., in press; Fleming et al., in press), whilst room-sharing with siblings does not carry the same protective effect (Scragg et al., 1996). These findings suggest that an active role by an adult caregiver is necessary before co-sleeping (and/or bed-sharing) can be beneficial, a finding which is consistent with, and supportive of, the hypothesis that mothers are extremely aware of, and responsive to, infants cues and environmental conditions when co-sleeping (McKenna, 1998).

However no environment is risk free. Bed-sharing infants of parents who smoke have been shown to be at a greater risk of SIDS (Blair et al., 1996; Mitchell et al., 1997). Recent parental alcohol consumption and extreme fatigue are other factors which may render an adult less responsive and must be taken into account when considering bed-sharing as a risk factor for SIDS (Bass et al., 1986; Fleming et al., 1996).

Consideration has also been given to the classic description of 'first night effects' offered by Agnew et al. (1966) in which researchers were warned about how care was needed to prevent over interpretation of sleep data collected on only one night in the laboratory. They argued that sleep is extremely susceptible to 'environmental manipulation'. As previously suggested by McKenna et al. (1990), the rationales and assumptions of this investigation depend on this idea. They suggest that not only are individuals sensitive to where they sleep, but also to with whom they sleep. The developmental and physiological needs of the human infant which have evolved are much less able to change and so change much more slowly than do the behaviours of parents who respond to them in culturally prescribed ways.

It is therefore important that sleep researchers question what has been accepted as the 'normal' development of circadian and/or ultradian based infant sleep behaviour, that defines as 'normal', infants who sleep through the night at very young ages. In a more evolutionary natural social sleep environment, which includes the mother, both parents, and/or siblings, it is likely that such sleeping arrangements influence and shape sleep patterns as they merge with, and are affected by, these social influences. It is quite possible that what is more convenient or in the best social interest of parents may not be in the infant's biological best interest (McKenna et al., 1990).

Despite similarities in the general environment for both of the night conditions in this investigation, clear differences in behaviour were observed between Routine Bed-Sharing and Routine Room-Sharing mother-infant pairs. These findings serve to strengthen the evidence that close proximity to a parent may have physiological and behavioural consequences for the infant.

Chapter 9

Proposal for a Standardised Behavioural Taxonomy

Laboratory studies of maternal and infant sleep behaviour are playing an increasing role in understanding possible mechanisms that may be of importance for both SIDS and other sleep-related disorders. Although the technology is now available to make these observations, there is no standardised taxonomy or 'set of rules' to define or measure the behavioural patterns and interactions observed. One of the main aims of this study was to define such a code based on the pioneering anthropological work of Professor James McKenna, specifically adjusted to the physiological observations set out for this and future studies.

The main hypotheses of this study were used as a basic structure for designing the behavioural code used in the analysis of the video data. During the development of the behavioural code used in this investigation, the author reviewed several behavioural taxonomies for coding behaviour and interactions used in previous studies examining co-sleeping practices (McKenna, 1995b; Ball and Hooker, 1999); mother-infant interaction (Kelmanson, 1993); infant sleep (Keefe et al., 1989); and primate behaviour (Astley et al., 1991), which were available in the published literature and through personal communication with fellow researchers.

A behavioural taxonomy constructed by medical anthropologist, Professor James McKenna, documented behaviour and interactions observed between solitary sleeping and co-sleeping mother-infant pairs (McKenna, 1995b). See Appendix J for the McKenna Behavioural Taxonomy. This taxonomy defined and described mother and infant vocalisations; body and facial orientations; sleep positions; sleep and awake periods; breastfeeding behaviours; movement behaviours; and grouped infant caregiving interventions, which did not involve feeding, into protective and affectionate non-nursing maternal interventions. The anthropological background and perspective from which McKenna approaches the study of mother-infant interactions during sleep were apparent in his attention to detail regarding the descriptions of mother-infant behaviour in his taxonomy.

Dr Helen Ball and Elaine Hooker, anthropologists from the University of Durham, are currently investigating dyadic and triadic co-sleeping behaviour in families with young infants in the northeast of England. These researchers have devised a behavioural code based on McKenna's taxonomy, which has been developed and expanded to acknowledge the presence of co-sleeping fathers (Ball and Hooker, 1999). See Appendix K for the Durham Behavioural Taxonomy. This taxonomy developed by Ball and Hooker (1999), addresses orientation and sleep position; bedding position; sleep state; and feeding behaviour, involving co-sleeping mothers, fathers and infants. Similarities between the Durham and McKenna taxonomies would allow some comparison of results between the populations of mothers and infants observed.

A major objective for designing the code used in the investigation reported in this thesis was to achieve a system which was 1) complex enough to document and reflect accurately the major behavioural and environmental variables known to have, or suspected of having, behavioural and physiological sequelae, 2) simple enough for practical and unambiguous recording of observations and 3) would allow a quantitative, as well qualitative, assessment of mother-infant behaviours and interactions.

Having considered the variety of coding approaches to video recordings previously documented (Astley et al., 1991; McKenna, 1995b; Ball and Hooker, 1999), and which were primarily descriptive, the author's aim was to develop a taxonomy for coding nocturnal mother-infant behaviour which allowed behaviours and interactions between mothers and infants to be quantified easily. The behavioural code subsequently developed by the author, and described in Chapter 5 of this thesis, addresses all of the areas included in the McKenna and Durham taxonomies, excluding the coding specific to fathers outlined by Ball and Hooker (1999). The method of coding behaviours and interactions was adapted to use numerical and alphabetical coding to simplify the grouping of behaviours, which in turn facilitated the quantification of behaviours during analysis. The code was also relatively time efficient to use, which is an advantage considering time, funding and human resource limitations; conditions under which many research projects are conducted. The taxonomy was also shown to produce a high degree of intra- and inter-observer reliability as discussed in Chapter 5 and Appendix H, demonstrating that it would be suitable for use within a multi-disciplinary research team.

The implementation of this taxonomy during the period of video data analysis and subsequent statistical analyses highlighted several areas within the behavioural code which could be modified and refined for use in future investigations of night-time infant care practices, as discussed in Chapter 9. The behavioural code, together with proposed modifications and rationale for these modifications, are outlined below.

Behavioural Taxonomy for Room-sharing and Bed-sharing Mother-Infant Pairs

Requirements: Spreadsheet computer package which allows first column of spreadsheet to be devoted to real time, divided into 30 second time intervals. See Appendix F for an example of an EXCEL spreadsheet which could be used with this behavioural taxonomy. Mother-infant pairs are allocated a separate spreadsheet for each night of recording. The video is reviewed first and manually coded onto log sheets. Data are then entered into the computerised spreadsheet. Manually coded logs serve as hard copies of the video data as well as a method of checking accuracy of the data entered onto the database, as previously discussed in Chapter 5.

Frequency and Duration of Movements and Noises

Code: Each movement and noise made by mothers and infants are timed and recorded.

- Enter real time start and stop times, duration of movement/noise in seconds.
- Enter an 'x' into the column adjacent to the duration of movement or noise to indicate whether event was a movement or noise or involved both movement and noise.
- Enter description of what the event involved in the adjacent column.
- Movements and noises occurring close together are considered separate, discrete events if 3 seconds or more separate the cessation of one movement or noise and the commencement of another.

Note: The EXCEL spreadsheet used in this investigation contained additional columns (two for mothers, two for infants) under the movements and noises section to allow records to be made of separate events which occurred within the same 30 second time interval.

Comments: The documentation of infant and mother movements and noises in this way facilitates the quantification of the frequency and duration of movements and noises, while the column which describes the movements and noises produced by the mother and baby in a shorthand form, (e.g. Sq - infant squirm: total head and body movement; H mvt - head movement), prevents the detail of these stimuli from being lost. See Appendix F for detailed account of shorthand abbreviations used. The data entered into this descriptive column are comparable to the movement and vocalisation behaviours described by McKenna in his taxonomy (See Appendix J). This behavioural code makes it possible to determine easily how many of the interactions were initiated by movement only, noise only, or a combination of both. Documentation of movement and noises in this way also allows important detail to be documented, thus making further analyses possible. A researcher, for example, could go back to the log records and quantify how many of the vocalisations made by infants were 'grunts' compared to 'cries'.

<u>*Interactions*</u>

Code: For each movement and/or noise which results in a response from the other member of the pair, document the 'initiator' of the interaction, 'responder' to the interaction, delay time (in seconds), and a description of the event.

- For each movement or noise which results in a response from the other member of the pair, enter a '<' or a '>' to indicate the initiator of, and the responder to, the interaction. i.e. baby > mother, symbolises a baby initiated interaction in which mother responded to stimuli produced by baby.
- Equally initiated or 'simultaneous' interactions are defined as interactions occurring between mother-infant pairs within the same one second time period, with a delay time of less than one second. An '=' symbolises an interaction between mother and infant which is simultaneous or equally initiated by both members of the pair.
- Enter delay time (time taken for other member of the pair to respond, in seconds) in appropriate column.

Comments: Documentation of interactions using this method allows simple analysis of how many interactions occurring during the period observed are baby initiated, mother initiated, or simultaneously occurring. These interactions may include breastfeeding episodes; maternal and infant adjustment of body position, talking and whispering by mothers to their infants; cuddling, stroking, patting, and kissing of infants by mothers, and mothers watching or appearing to check their infants following infant initiated movement or noise. Documentation of the details of what occurred during these interactions also enables further analyses to be performed. For example, the number of breastfeeding episodes initiated by baby could be compared to those episodes initiated by mother, or the frequency of adjustment of infant bedding by mothers during the night could be quantified.

Breastfeeding

Code: Breastfeeds are recorded in the interaction section of the behavioural code.

- A breastfeeding episode is defined as beginning and ending with nipple attachment and detachment respectively, and includes very short interruptions during which mother changes baby over from one breast to the other. These interruptions are usually a matter of seconds and within the 30 second time period.
- A new breastfeeding episode is scored if breastfeeding is interrupted by maternal behaviours which indicate an apparent attempt by the mother to terminate feeding, but the infant's subsequent refusal to settle prompt the mother to reinitiate feeding, and the new episode commences at least three minutes after the cessation of the previous episode.

Comments: Breastfeeding behaviour is quantified using an adaptation of the breastfeeding criteria described by McKenna, with the additional criteria that a breastfeeding episode is considered a separate episode when it commences more than three minutes after the cessation of a previous episode. McKenna describes breastfeeding behaviour in terms of breastfeeding episodes which may or may not make up a breastfeeding session. McKenna's definition of a breastfeeding episode was the same as in the above code, however a new episode was coded if breastfeeding was interrupted by maternal behaviours which indicated an apparent attempt by the mother to terminate feeding (i.e. by closing bra or nightgown, by attempting to leave room, attempting to return to sleep) but the infant's subsequent refusal to settle prompted the mother to reinitiate feeding (McKenna et al., 1997). McKenna's definition does not include a time scale. Using this definition it is possible that a mother who stops feeding briefly but resumes feeding within a couple of minutes, is scored as having two breastfeeding episodes. The behavioural code used in this investigation defines a breastfeeding episode as a separate episode when it commences more than three minutes after the cessation of a previous episode. The author believes the inclusion of a time scale helps to present a more accurate assessment of night-time frequency of breastfeeds and a clearer picture of night-time breastfeeding behaviour.

Interestingly, within the investigation reported in this thesis, the time scale was only necessary to clarify breastfeeding episodes on a couple of occasions. For the vast majority of mother-infant pairs, breastfeeding episodes were distinct, separate episodes often separated by several hours. This pattern may be reflective of 'baby-led' feeding promoted in the United Kingdom, in which mothers are encouraged to offer babies the breast, and allow them to feed from that breast until satiated, in contrast to timing the breastfeed and possibly interrupting the feed before the baby has finished. This advice suggests that the baby who has been well attached will let go of the breast when he has had enough milk from that side. His body language will let the mother know whether he is satisfied, and if he cries or searches for more milk, the second breast is offered (Renfrew et al., 1990; Henschel and Inch, 1996).

McKenna's taxonomy included detailed descriptions of specific breastfeeding behaviours, e.g. nipple mouthing, present nipple, reject nipple, etc. See Appendix J. In the proposed standardised taxonomy many of these behaviours are grouped into one event which is recorded as 'preparing for feed' to simplify coding. These 'preparing for feed' behaviours include adjustment of mother and infant body positions and clothing in preparation for the feed, and are timed and documented in the interaction section of the code.

Proximity

Original Code: The taxonomy used in this investigation coded head and body proximity between mothers and their infants using distances grouped into three bins which were in multiples of 20cm, for the reasons described in Chapter 5. Head and body distances were coded separately and entered onto the spreadsheet in two columns specifically documenting these data. During analyses it became apparent that by employing this scale to determine patterns of behaviour with regard to proximity between mother-infant pairs, it was possible that subtle differences between Routine Bed-Sharing and Routine Room-Sharing pairs may have been overlooked, as discussed in Chapter 8. McKenna and colleagues used four bins of 10 cm in their study of co-sleeping mother-infant pairs: bin 1, < 10 cm; bin 2, 11-20 cm; bin 3, 21-30 cm; bin 4, > 30 cm (Richard et al., 1996). Interestingly, in their study a single bed was used, limiting the distance which separated bed-sharing mother-infant pairs, reflected in their maximium distance category of '>30cm'. To facilitate comparisons between sample populations in future studies investigating room-sharing and bed-sharing, the author proposes that the measures for proximity in the existing behavioural code should be modified and extended in ways similar to McKenna's coding for distance, in terms of small, uniform bins.

Proposed modifications for coding proximity between mother-infant pairs:

- Code head and body distances separately.
- Calculate head or face distance by measuring distance on video screen between pair's nares and compute actual distance using markers visible in the video field.
- Calculate body distance by measuring distance on video screen between pair's trunk or limbs (whichever is closest to other member of the pair) and compute actual distance using markers visible in video field.
- Group the distances between mother and infant into 11 bins which are in multiples of 10cm:-

Bin 1: less than 10 cm
Bin 2: 11-20 cm
Bin 3: 21-30cm
Bin 4: 31-40 cm
Bin 5: 41-50 cm
Bin 6: 51-60 cm
Bin 7: 61-70 cm
Bin 8: 71-80 cm
Bin 9: 81-90 cm
Bin 10: 91-100 cm
Bin 11: over 100 cm

Comments: Coding of proximity between mother-infant pairs using this scale is comparable with the distance bins used by McKenna, while still retaining the original idea of proximity in relation to a baby's arm reach (Bin 1 and 2), within a mother's arm reach (Bins 1-6), and beyond a mother's arm reach (Bin 7-11). In addition, the proposed code addresses the maximum possible distances between mothers and infants sleeping in a standard double bed. Proximity is recorded in more detail, providing an opportunity to detect more subtle differences between groups of mother-infant pairs if differences are present.

Body Position and Orientation

Code: Head and body positioning and physical orientation of mother and baby are described in relation to each other using a two letter code. Body position and orientation are coded separately and entered onto the spreadsheet in two columns specifically documenting these data.

- Record maternal and infant body position and orientation first using the following alphabetical code: S, supine; P, prone; T, towards - lateral position (side-lying) with ventral body surface facing towards other member of the pair; A, away - lateral position with ventral body surface facing away from other member of the pair.
- Secondly, record maternal and infant facial orientation using the following alphabetical code: U, up - head and face in midline orientation facing towards ceiling; D, down - head and face in midline orientation, facing down; T, towards - head and face orientated towards the other member of the pair, regardless of body position; A, away - head and face orientated away from other member of the pair, regardless of body position.
- If mother or baby are not visible, code 'DK' for 'don't know'.
- Examples: baby SU: baby supine, face and head in midline, facing upwards; mother TT: mother side-lying, ventrum towards baby, with head and face also facing baby.

Comments: The taxonomy combines body position and physical orientation in a simple, effective, two letter code, which addresses all the possible combinations of position and orientation without losing important information. This method of recording such position and orientation data avoids having to use many combinations of coding to represent a mother or infant's body position and orientation in relation to the other member of the pair. For example, using McKenna's code (See Appendix J) a mother who is observed to be supine with her face looking towards her infant is coded using the combination of 'mfi' (mother faces infant) and 'supine' (either mother or infant sleeps or is awake or lying on back). Using the Durham taxonomy this behaviour is documented as 'mfi' (mother facing infant) and 'msu' (mother supine position). In the proposed taxonomy, the same behaviour is represented as 'ST' in the column of the spreadsheet documenting mother's orientation. This method also proved to facilitate the quantification of periods of the night spent in specific body positions and orientations during the analyses.

Physical Contact

Code: The amount of time that mother-infant pairs spend in physical contact during the night is recorded in the 'Touch' section of the behavioural code, which consists of three columns on the spreadsheet.

- Describe contact in relation to which parts of the mother's and infant's body are touching using standard abbreviations (see Appendix F) and record in the two appropriate columns of the code.
- Indicate the initiator of the contact, i.e. whether the contact was mother, baby or equally initiated, by using the symbols '>', '<', and '=' in the appropriate column of code.
- Example: BTA (mother column) = FTA (baby column). Explanation: baby is feeding with his/her face, trunk and arms in contact with mother's breast, trunk and arms. The '=' symbol is used if the baby initiated the feed and is actively suckling and the mother responds by offering her breast and making the feed possible by her body position and support of the infant. See Appendix F for further examples.
- If physical contact which is observed to be occurring between the pair is obscured by bedding for short periods, only code contact after consideration of the following criteria:

  a) there has been prior contact and i) body positions remain the same; ii) head and body proximity remains the same or less.

  b) proximity of head and/or body was less than 20 cm between the pair; and body positions and orientations face towards each other with/without arms extended toward the other member of the pair. When head distance between mother-baby pair is less than 20 cm and both members of pair are supine or side-lying it is considered very unlikely that no contact occurs under the bedcovers.

  c) bedding position and shape of covers around mother and baby indicates that touch or pressure is being exerted through or under the bedding. This includes contact made when a mother positions her arm/s over bedding and across her infant's body. See Illustration 7.4, Chapter 7 for an example of this behaviour.

  Note: Re-evaluate physical contact after each movement or noise made by mother or baby using the above criteria.

Comments: This behavioural code achieves the aim of documenting significant sensory stimuli in the form of physical contact, to which either member of the mother-baby pair may respond. The simple format for describing sometimes complex interactions and contact assisted in the transcription of video data to the computerised format, without losing important detail, which in turn facilitated statistical analyses of these data. Further analyses of physical contact in relation to which parts of the body are most frequently in contact; who initiates this contact; in addition to quantifying the time mothers and infants spend during the night in physical contact, are possible using this taxonomy.

<u>Bedding</u>

Code: The behavioural taxonomy described the type of bedding chosen by mothers to use for their infants and themselves, and the level to which it was placed, and ended up during the night, on the body of the infant and the mother. The bedding section within the spreadsheet consists of four columns to allow positioning and layers of bedding for mothers and infants to be documented separately.

- Code categories of all bedding types which are used in the investigation. For example, this study included a) standard 10 tog duvet; b) single layer sheet; c) cellular blankets.
- Calculate the number of layers of blankets/covering used. This study included i) 1 air cell; ii) 2 air cells; iii) 3 air cells; iv) 4 or more air cells. This method also accounts for folding of blankets/bedding which may occur. See Appendix F for examples.
- Document clothing worn by mother and baby, and if this changes during the night.
- Document position of bedding on body of mother and infant using the following categories which describe positioning in terms of 'levels' of bedding. Mother or infant is covered by bedding to i) Level 1, trunk to shoulder level (neck) with both arms covered by bedding; ii) Level 2, trunk to shoulder level with one or both arms uncovered; iii) Level 3, trunk to midchest (epigastric) level; iv) Level 4, trunk to level of hips; v) Level 5, body completely uncovered by bedding; vi) Level 6, head and body completely covered by bedding.
- Add further categories of bedding if necessary to account for the wide variety of bedding available for use in home situations.

- Periods of time in which mothers left the bed or room, and were therefore completely uncovered by bedding e.g. to change either their infant's nappy or clothing, or to visit the bathroom are excluded from maternal bedding analysis.

Comments: This taxonomy, embedded in a nursing and medical approach to variables which may influence the risk of SIDS, is also more detailed with respect to bedding/clothing variables than both the Durham taxonomy, which categorises levels of bedding into three groups, or the McKenna taxonomy, which does not mention levels of bedding. In the thermally controlled laboratory which remained at a constant temperature between 18-22°C, mothers rarely placed more than 4 layers of air cell blankets on infants. To account for varying thermal conditions within the home situation, additional categories for the number of layers of blankets used to cover infants or mothers could be simply added to this taxonomy. The taxonomy provides detailed information on infant bedding and clothing, together with the proportion of body or surface area covered by each garment and item of bedding which allows an effective total thermal resistance for the coverings on each infant and mother to be calculated. During the analyses involved in this investigation, observations of bedding use and thermal resistance with regard to infants were the primary focus, due to previous studies drawing attention to the increased risk of SIDS associated with heavy wrapping, soft bedding and infant head covering (Fleming et al., 1990; Fleming and Blair, 1997; Kemp et al., 1994; Wilson et al., 1994). This coding system however, facilitates the quantification of thermal resistance and bedding use, in terms of the types of bedding chosen and the way it is used, for both mothers and infants.

<u>Sleep Staging</u>

Coding: Observations of sleep state are made for mother and baby from their video recordings. Infant sleep state observations are then replaced with sleep states deduced from analysis of overnight polysomnograms recorded from the infants. Two columns of the behavioural code document mother and infant sleep/wake states separately.

- Maternal sleep/wake states are based on observations of the mother in which each minute of the recording was categorised as to whether the mother is awake or asleep.

- Awake periods are defined when the mother's eyes are open for at least five seconds. These periods are usually accompanied by sustained gross body movements, irregular breathing and vocalisation directed towards the infant.
- Asleep periods are defined when the mother's eyes are closed for at least five seconds, and are usually accompanied by regular breathing, and occasionally snoring. There is an absence of gross body movement, however the presence of twitches and brief head movements are permitted.
- Where the observer is not certain of sleep/wake state, the period is categorised as 'appears awake', ' appears asleep' or 'state not known'.
- Code each 30 second interval using observational sleep staging criteria for both mother and baby:

A	Awake
a	appears awake
s	appears asleep
S	Asleep
DK	Don't know: state not known

- Replace observational infant sleep staging criteria with polysomnographic sleep state data.
- Infant sleep staging is performed off line by review of each minute of the polysomnogram using the EEG, EOG, respiratory, ECG and video channels in a modification of the methods of Anders et al., (1971) and Stefanski et al., (1984), previously described by Azaz et al., (1992).
- Changes in infant sleep state are scored if they lasted 2 minutes or more, and arousals of more than 2 minutes are recorded as awake periods.
- For studies including infants of 2 months of age or less, only active and quiet sleep are classified, with no subdivision of quiet sleep. Indeterminate sleep generally occurs at the boundary between quiet and active sleep, and is recorded as indeterminate for the purposes of analysis.
- Coding for infant sleep state using polysomnographic data:

4	Awake
3	REM (Rapid Eye Movement) Sleep
2	Unknown
1	Quiet Sleep

Comments: Due to the need for consistency and the wide age range of infants studied in this investigation (from 1 to 5 months), only active and quiet sleep were categorised with no subdivision of quiet sleep, as this cannot be reliably performed in infants aged 2 months or less. In future investigations which sample infants older than 2 months of age, analysis of infant polysomnographic data with subdivision of quiet sleep into Stages 1-2 and Stages 3-4 would be possible. Such results could then be compared to results reported from studies conducted by McKenna and colleagues (McKenna et al., 1993; Mosko et al., 1996, 1997a) who studied infants at 3 months of age. In addition, McKenna and colleagues recorded polysomnographic data from mothers and analysed these data using the Rechtschaffen and Kales (1968) system for young adults (McKenna et al., 1990; 1993; Mosko et al., 1996; 1997a). This facilitated complex analysis of synchronous mother-infant arousal and sleep states, but required complex monitoring of mothers which restricted their mobility and required mothers to be detached from monitoring equipment by a technician to attend to their infant if solitary sleeping, or for trips to the bathroom. It is possible that these restrictions and the presence of a third party (the technician) may have impacted on the type, frequency and duration of interactions which occur between mother-infant pairs during the night. In the investigation reported in this thesis, a decision was made not to make polysomnographic recordings of mothers in an effort to avoid restricting maternal mobility and interventions with their baby during the night. Observations of sleep/wake behaviour in this study were therefore restricted to more simple analyses, however we believe a more accurate picture of mother-infant behaviour and interactions was achieved as mothers and infants were left, for the greater majority, undisturbed for the entire night of recording.

<u>*Comments Section*</u>

A column of the behavioural code is allocated to a comments section. This section allows thumb and finger sucking behaviours, dummy use, and video tape changes to be documented, and mother-baby interactions, bedding arrangements, and unusual occurrences to be described in more detail. This section has been utilised in the analyses of physiological variables with regard to infant sucking behaviour (Pollard et al., 1997). Details of events which do not fall into the specific categories in the code may also be documented in the comments section in relation to when and how they happen, thereby preventing any detail of behavioural interactions between mother-infant pairs from being lost in the simple coding system. Although observations in this section are not specifically categorised it is important to be consistent, in that when a particular behaviour is observed it is consistently reported for all subjects and for each night of recording.

Summary

The behavioural code developed for use in this investigation proved to be an accurate and user friendly method of recording mother-infant behaviour and interactions from large volumes of video data. The code was complex enough to document, and reflect accurately, the major behavioural and environmental variables known to have, and suspected of having, behavioural and physiological sequelae for mothers and their infants, while being simple enough to be used in a time efficient manner, and produce a high degree of intra- and inter-observer reliability. This taxonomy also encompassed all of the variables examined in previously documented taxonomies of night-time mother-infant behaviour and interaction (McKenna, 1995c; Ball and Hooker, 1999), which therefore facilitates some comparison of results between the different sample populations studied. The coding system and the methods used in transcription of video data to spreadsheets in preparation for analysis also facilitated the statistical analyses of the variables under investigation. By documenting behaviour and interactions using 30 second time periods, matching physiological data recording intervals, this behavioural taxonomy also achieved the objective of providing a tool for integrating the understanding of the behaviour of mother-infant pairs when bed-sharing and room-sharing, with maternal and infant physiological responses associated with that behaviour. Analyses in future investigations, using the same or a modified coding system, will be able to examine more closely both maternal and infant physiological responses to specific behaviours and interactions occurring between mother-infant pairs. Future studies which include observations of the role of the father and potential influences he may have on mother, on baby, and on the mother-baby dyad, will require further adaptations to the existing taxonomy.

The author proposes the behavioural code outlined above as a standardised behavioural taxonomy suitable for utilisation in future multidisciplinary investigations of night-time infant care strategies, including room-sharing and bed-sharing practices. Collaboration between researchers studying co-sleeping practices, in defining the conditions and variables under investigation, will allow the comparison of results across sample populations.

Chapter 10

Conclusion

During the course of this investigation it became apparent that bed-sharing encompasses a wide range of practices, even within a relatively homogeneous, Caucasian, well educated and predominantly middle class study group.

Some observations were common to all mother-infant pairs regardless of routine practice or the particular sleeping condition. All mothers were observed to place their infants supine to sleep. The prone position was rarely used, and only when settling infants to sleep on their mother's chest. Mothers were therefore almost always awake when infants were prone. At no time was a mother ever observed to roll on her infant. Mothers in both groups and on both night conditions were observed to check room and baby temperature and frequently made bedding adjustments. Babies rarely became completely covered by bedding, with bedding on both night conditions most commonly placed at the level of the infants' shoulders, with one or both arms free. Mother and baby sleep/wake states demonstrated some concordance. Generally, all mothers were more likely to be awake when their babies were awake or in REM sleep, and were more likely to be asleep when their babies were in Quiet sleep. Although there were differences in the frequency and duration of breastfeeding episodes between the two groups, the total feeding time was not significantly different. Babies in both groups initiated more interactions during the night than their mothers, while mothers from both groups were observed to respond to a greater number of baby-initiated interactions, than babies responded to mother-initiated interactions. Babies generally spent more time in body orientations which faced their mothers, than mothers did in orientations which faced their babies.

Similar differences in mother-infant behaviour and interactions were observed between the room-sharing and bed-sharing conditions, regardless of routine condition. All mothers spent more time awake during the night on bed-sharing nights compared to room-sharing nights. Consequently both groups spent more time asleep on room-sharing nights than they did on bed-sharing nights. On bed-sharing nights all mothers were more likely to be awake when their infants were in REM sleep. The total number of interactions occurring during the night was greater on bed-sharing nights compared to room-sharing nights in both groups, and mothers responded more rapidly to baby-initiated interactions when bed-sharing, however interindividual variations were wide. Bed-sharing mothers in both groups responded more quickly and frequently than room-sharing mothers to baby movements not accompanied by an audible sound. Interestingly, both groups of mother-infant pairs had more frequent breastfeeding episodes on their room-sharing nights compared to their bed-sharing nights. As one would expect, the proximity between mother-infant pairs was closer on bed-sharing nights compared to room-sharing nights. Mother-baby pairs in both groups spent more time in physical contact and in orientations which faced each other on bed-sharing nights compared to room-sharing nights. When in face-to-face orientations, bed-sharing pairs slept most of this time less than 20 cm apart. When bed-sharing, mothers more frequently secured the duvet under their own arm, which prevented it moving over their shoulder during sleep and covering their baby's head. The majority of mothers also shared a duvet with their baby when bed-sharing, resulting in a greater median level of thermal insulation on bed-sharing nights for both groups of babies compared to room-sharing nights. On room-sharing nights, mothers in both groups chose layered air cell blankets to cover their infants, and levels of insulation for both groups on room-sharing nights were almost identical.

Clear differences were observed between mothers and infants who routinely bed-shared and routinely room-shared. The largest differences in the variables examined were found, with few exceptions, between the two groups in their routine conditions; that is, Routine Room-Sharers on room-sharing nights compared to Routine Bed-Sharers on bed-sharing nights. There was a trend for Routine Bed-Sharing pairs to have a greater concordance in awake states than Routine Room-Sharing pairs during both night conditions. Routine Bed-Sharing pairs had more interactions on bed-sharing nights than Routine Room-Sharing pairs did on room-sharing nights, the majority of which were baby initiated. Maternal responses to baby initiated interactions often appeared to prolong these infant arousals, and this observation is supported by the finding that Routine Bed-Sharing infants spent longer periods of time in movement and noise on both nights than Routine Room-Sharing infants. Routine Bed-Sharing babies on bed-sharing nights also breastfed twice as many times as Routine Room-Sharing infants on both night conditions, however the feeds were of shorter duration. Routine Bed-Sharing infants were more likely to be observed in the side-lying position than Routine Room-Sharing infants on both night conditions. Routine Bed-Sharing pairs more frequently adopted a body orientation which faced each other and which facilitated close physical proximity and contact compared to Routine Room-Sharing pairs. Routine Bed-Sharing mothers shared a duvet with their babies for the majority of the night when bed-sharing, while Routine Room-Sharing mothers were more likely to use a combination of blankets to cover infants. No harmful interactions were observed.

Although there were several important differences in study design, many of these findings are consistent with those reported from studies conducted by McKenna, Mosko and colleagues (McKenna et al., 1990; 1997; McKenna and Mosko, 1994; Mosko et al., 1996; 1997a; 1997b; 1997c; Richard et al., 1996), and provide evidence to support the view that social care of infants is practically synonymous with physical regulation. Mother-infant pairs observed by McKenna and colleagues experienced different environmental conditions on the two study nights: bed-sharing and solitary sleeping in a separate room. Therefore observations from this investigation which identified differences in maternal and infant behaviour when mother-infant pairs shared the same general environment, that is when bed-sharing and room-sharing, are even more striking, and further support evidence which suggests that maternal sensitivity and responsiveness to infant stimuli are enhanced when bed-sharing.

This investigation was intended as a small, intensive pilot study to investigate the nature and extent of behavioural and physiological interactions between mothers and their normal infants during times of sleep. It is the first reported investigation to examine directly the differences between mothers and infants who routinely room-share, and those who routinely share a bed with their baby. Both of these practices have been associated with influencing the risk of SIDS: room-sharing with a reduced risk of SIDS; and bed-sharing with an increased risk of SIDS for infants of parents who smoke.

Whilst the importance of being able to study mothers and infants in their 'natural state' in the community is recognised from previous investigations (Wigfield et al., 1993), many of the environmental conditions which may influence infant care (e.g. temperature), are not within the researchers' control. Thus, there was a need to combine observational recordings of mothers and infants at home with recordings in the laboratory, in which certain environmental conditions could be precisely controlled. The infra red video facility in the sleep laboratory allowed mothers and infants to sleep undisturbed whilst infants were subject to detailed, non-intrusive physiological monitoring. The closeness of the relationship between mothers and infants, and the role of the mother as the potential effector of homeostatic conditions for the infant, makes the findings from this investigation particularly important and serves as a starting point for future studies based in the community which investigate the practices of room-sharing and bed-sharing.

The limited number of subjects who participated in this investigation does not permit any conclusions to be drawn, but no deleterious effects of bed-sharing were observed. In addition, the demographics of this sample of mother-infant pairs represented a relatively homogeneous, educated, middle-class, Caucasian study group of low risk for SIDS and therefore findings from this investigation cannot be generalised to the wider population or to groups considered at an increased risk of SIDS.

Despite several limitations, this intensive investigation serves as a resource in determining the feasibility of a larger, community based study of infant care practices and identifies the important interactions to examine. The standardised behavioural taxonomy which has been proposed is an accurate, user-friendly and relatively time efficient system for documenting mother-infant behaviour and interactions, and is suitable for utilisation in future multidisciplinary investigations of night-time infant care strategies in the laboratory or community. In addition, the documentation of night-time mother-infant behaviour and its effect on infant physiology in a low risk group provides valuable information on the physiological development of the infant; forms a basis for understanding high risk groups; and may contribute to developing better advice for parents on optimal care practices for their babies at night.

As the primary caretaker for breastfed infants is, by necessity, usually the mother, the priority was to study the mother-infant dyad as a first investigation into bed-sharing. In the United Kingdom, over 70% of bed-sharing mothers put themselves between the baby and their partner, so that the baby was effectively sharing with one adult (Fleming et al., 1996; Fleming et al., in press). Future studies will need to address the effects on the mother-baby dyad of having the father and/or sibling(s) present. One study, currently being conducted in the northeast of England, and investigating parental strategies for the night-time care of infants, is addressing the behavioural effects of triadic co-sleeping in which both parents bed-share with their baby (Ball and Hooker, 1998). Although this small study offers limited information regarding the effects of triadic co-sleeping on infant physiology, it does offer a valuable starting point for future studies based in the community.

Further research in the home environment, based on similar designs to the investigation reported in this thesis and the studies reported by McKenna and colleagues (McKenna et al .,1990; Mosko et al., 1996; 1997a; 1997b; 1997c; Richard et al., 1996) and Ball and Hooker (1998), with broader inclusion criteria to incorporate families identified epidemiologically as being at normal or at increased risk of SIDS, are urgently needed to address the effects of night-time infant care strategies. This will allow the quantification of differences in both behavioural and physiological interactions and may identify possible physiological mechanisms for epidemiological risk factors. Ultimately, such studies will allow an assessment of how variation in social and environmental circumstances affect co-sleeping practices (including both bed-sharing and room-sharing) and infant safety. An understanding of the mechanism by which such factors exert their effects is important in designing focused intervention campaigns to reduce further the risk of SIDS for such groups.

Studies investigating the epidemiology of SIDS have not found direct evidence of any 'protective' effects of bed-sharing. The strength of the 'risk' associated with bed-sharing appears to be dependent on how the individual study defines bed-sharing, and which confounding factors are taken into consideration in the multivariate model. Bed-sharing encompasses a wide range of practices even within relatively homogeneous, Caucasian study groups (Heron, 1994; Young et al., 1998). Some aspects of bed-sharing in cultural groups for whom this is an accepted approach to childcare are likely to be different from groups for whom this practice is not the cultural norm. Cross-cultural (Lozoff and Brittenham, 1979; Morelli et al., 1992) and descriptive studies (Gantley et al., 1993) of infant care practices have all studied families in which bed-sharing is the accepted sleeping environment and the prevalence of maternal smoking is very low (Nelson and

Chan, 1996). Bed-sharing amongst socioeconomically disadvantaged groups in a Western society, within which smoking and alcohol use are common and breastfeeding is rare, may be accompanied by risks related to the environment in which it occurs [e.g. on sofas or couches, where there is a risk of entrapment of infants (Fleming et al., 1996; Blair et al., in press)]. For as Gantley et al. (1993) have emphasised, it is imperative not to transcribe blindly practices from one culture to another. In societies where bed-sharing is the cultural norm, it would be harmful to try to stop this practice, just as it might be to introduce it into a population where bed-sharing is unfamiliar (Davies, 1994; Gantley et al., 1993). Such cultural factors complicate the interpretation of the data on bed-sharing practices, which is further complicated by the presence and position of the father. As mentioned previously, community studies have indicated that the most common sleeping arrangement by bed-sharing families was for mother to sleep between the baby and the father (Fleming et al., 1996). In the investigation reported in this thesis, fathers were not present as it was felt important to investigate mother-baby interactions before introducing the presence of a third person.

The context in which bed-sharing occurs is therefore important when considering safety issues and associated risks of SIDS which have been raised in the literature (Mitchell, 1996). As McKenna and colleagues (1993) so succinctly state:

> 'Co-sleeping is not a unitary phenomenon. The sleep environment consists of many different kinds of possible co-factors that may alter infant physiology and consequently influence SIDS risk. Co-sleeping is a condition in which other SIDS risk factors such as overbundling, dangerous (soft and fluffy) bedding, infant sleeping position, environmental temperature and a range of internal conditions may be altered, thereby changing the infant's risk of succumbing to SIDS.' (McKenna et al., 1993, p. 264).

Certain data are needed to assess the environmental context of co-sleeping, in addition to the benefits and risks associated with co-sleeping (McKenna, 1995a; 1995c). These environmental data include the characteristics of sleeping surfaces or structures, including size, firmness, type of fabric, cleanliness; the characteristics of co-sleepers including number, ages, mental health and/or physiological status, motivations and attitudes; the quality of the air, including the presence of smoke, air currents, room temperature and humidity; and the sleeping arrangements and items in the bed, including whether the infant is placed *on* the covers or *in* the bed, exactly how the infant is placed in relation to covers, pillows and bed objects, and where the infant sleeps in relation to fellow co-sleepers. Data needed to assess the benefits versus the risks of co-sleeping include whether the mother smoked during or after pregnancy; the use of alcohol or legal/illegal drugs that may affect sleep state; the stability in where, how and with whom the infant sleeps; maternal age, education, economic status and support structures; breastfeeding status; and routine infant sleep position (McKenna, 1995a; 1995c). Although there is no guaranteed protection against SIDS, and many infants who die from SIDS have no known risk factors, from a combined anthropological and clinical perspective, McKenna (1995c) has proposed a model of the ideal 'SIDS resistant' environment. See Figure 10.1.

Figure 10.1

Ideal SIDS Resistant Caregiving Complex
Exclusive, intense, breastfeeding for the first six months, in the context of supine, social sleep day and night, with maximum infant holding, carrying and attention.
Pre and post natal maternal social support and education, with an absence of maternal smoking, drug and alcohol abuse.
Safe environmental conditions: smoke free home; safe bedding design, materials and conditions of co-sleepers; thermal care
Adapted from 'Child Care Practices and SIDS'. Slide presentation by Professor J. McKenna (1995c)

Research evidence to date has not suggested that sensory contact in the form of bed-sharing or co-sleeping will eliminate SIDS, or that it is practical and safe for all families (McKenna, 1995c). Infant characteristics may interact with micro-environmental factors relevant to bed-sharing and ultimately affect the infant in his or her setting (McKenna 1995c). At this point in the understanding of the effects of bed-sharing, the practice can neither be recommended nor advised against. However the integrated care system which incorporates co-sleeping with parents is the result of millions of years of evolution. One would therefore imagine that it must provide social, physiological and psychological benefits for those involved. The question is therefore not whether parents should sleep with their babies or not, but rather that research should examine co-sleeping practices and the potential role they may have in contributing to infant survival (McKenna 1995c). The existence of dangerous co-sleeping conditions is no more an argument against the potential benefits of bed-sharing with infants, than the existence of dangerous solitary infant sleep environments constitutes a valid argument against the safety of all solitary infant sleep. No environment is risk free. The evidence presented in the literature to date justifies further research into the effects of adult contact on infant sleep physiology and behaviour.

It is also evident from epidemiological (Fleming et al., 1996; Mitchell et al., 1997), questionnaire (Heron, 1994; Hooker, 1995; Mosenkis, 1998), and interview based studies (Ball et al., in press), that bed-sharing in some form, whether occasional, frequent, or 'all night, every night', is common in Western societies even when this is not the accepted cultural norm. It is therefore essential that parents are provided with information regarding both the benefits of, and the risk factors associated with, bed-sharing, so that they can make an informed decision about this infant care practice.

The need to provide parents with information to allow informed choices about night-time infant care strategies has been addressed by some health care professionals; predominantly midwives working in maternity service provision. As part of the Baby Friendly Initiative, launched in 1991 by the World Health Organisation (WHO) and UNICEF to encourage hospitals world-wide to adopt practices that protect, promote and support breastfeeding (WHO, 1989), several hospitals in the United Kingdom have written protocols for bed-sharing with babies while in hospital. Ashmore (1997) reports a 'Babies in Bed' policy in a large city hospital, which was devised in an attempt to encourage mothers to feed their babies as often as required, whilst still allowing them to rest. Small cot sides were provided, no duvets were allowed, and criteria regarding mother and baby's condition were listed (Ashmore, 1997). Following introduction of this policy the rates of supplementation with infant formula for term, healthy newborns were reduced by half. See Appendix L for an example of the policy currently used at the Jessop Hospital for Women, Sheffield, England.

From a review of the available literature, the following recommendations can be made regarding the practices of room-sharing and bed-sharing. Unless otherwise directed by a physician, healthy infants should be placed down to sleep supine, whatever the sleep environment. In the first year of life, infants should share the same bedroom as their parents (Mitchell and Thompson, 1995; Mitchell et al., 1997; Blair et al., in press), and infants should not sleep in the same bed as their parents if the mother is a smoker (Mitchell and Thompson, 1995; Fleming et al., 1996; Mitchell et al., 1997). Unlike cots, which are designed to meet safety standards for infants, adult beds and sofas are not so designed and may carry a risk of accidental entrapment and suffocation (Kattwinkel et al., 1997; McKenna, 1998). Results from the CESDI SUDI study have shown that bed-sharing was only a risk factor for particular groups under particular circumstances. There was no increased risk of SIDS associated with bed-sharing for infants of non-smoking parents, infants older than 14 weeks, or babies who bed-shared and were placed back in their own cots (Blair et al., in press). The risk associated with bed-sharing among younger infants appears to be predominantly associated with recent parental consumption of alcohol, overcrowding, extreme parental fatigue, and when the infant was under a duvet.

Advice such as all babies should be returned to their cot after breastfeeding (Department of Health, 1996) errs on the side of caution, and further study is required before such a statement could or could not be made a definitive one. There is no published evidence of any increased risk to a baby from sharing a bed with a firm mattress with parents who do not smoke and who have not consumed alcohol or other drugs, provided the bedding is arranged so that it cannot slip over the baby's head and the baby is not sleeping on a pillow or under an adult duvet (Fleming et al., 1996; Mitchell et al., 1997; Blair et al., in press). Advice to parents who wish to bed-share should include the recommendations proposed in Table 10.1.

Table 10.1 Advice for parents who wish to bed-share with their babies :
1. Place babies on their backs to sleep. 2. Do not bed-share if you are a smoker. There is currently no evidence to suggest that a mother who smokes and who wishes to breastfeed in bed, but then returns her baby to the cot, is placing her baby at a greater risk of SIDS. 3. Do not bed-share if you or your partner consume alcohol prior to sleep. 4. Do not bed-share if you have recently taken illegal substances which may affect your sleep state. 5. Do not bed-share if you take any medications which may cause sedation. 6. Do not sleep with your baby if you are extremely fatigued or jet-lagged. 7. Do not sleep with your baby on a sofa. 8. Ensure that the baby is free to move his/her limbs, i.e. not swaddled. 9. Avoid overheating. For sleep, choose lightweight blankets and clothing which can be used as layers. 10. Care should be taken to avoid using soft sleeping surfaces. Duvets, quilts, pillows, blankets, or other similar soft materials should not be placed under the baby. 11. Avoid covering the baby with an infant or adult duvet or quilt. 12. If possible sleep on a larger sleeping surface, i.e. use a big bed with few sleepers. 13. The bed should be structured and positioned so baby cannot fall out. 14. Avoid bed-sharing on a waterbed.

Sudden infant death syndrome has been described by Bergman (1986) as

> 'like a nuclear explosion where a critical mass must be obtained before the event is to occur' (Bergman, 1986, p. 17).

This study represents a midpoint between epidemiological linking of incidence in particular populations with particular infant care practices and the investigation of possible physiological mechanisms. It stands alone as a study of night-time mother-infant behaviour and physiology and of infant care practices, but it is hoped that it contributes to a discussion of those factors which form Bergman's 'critical mass'.

Documenting night-time mother-baby behaviour and its effects on infant physiology in a group at low risk of SIDS forms a basis on which to understand high risk groups. McKenna (1995a) points out that SIDS is

> 'a disorder for which existing research paradigms have proved inadequate' (McKenna, 1995a, p. 264).

A recognition of the legitimacy of diverse sleeping arrangements for infants, including bed-sharing and room-sharing practices, is necessary in reaching a complete understanding of SIDS (McKenna, 1995c). Results of this investigation contribute to evolutionary, cross-cultural and epidemiological evidence which suggests that the conditions within which bed-sharing occurs, and not the act itself, is what is critical in assessing the likelihood of positive or negative consequences.

There is a need for collaboration between research groups investigating bed-sharing and its behavioural and physiological effects on parents and infants in cultural groups across the world, to define precisely the conditions and variables under investigation. Recommendations drawn from the conclusions of these investigations should distinguish between potentially hazardous sleeping environments and the effects of close contact between mothers and their babies.

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Appendices

Appendix A

Home Sleep Logs

HOME SLEEP LOG

Date

Day of week

Name

DOB

Study number

Weight (Kg) OFC (cm)

Age
(weeks and days)

How are you currently feeding your baby ?

Breast ....
Bottle ....
Mainly breast and ocassional bottle ....
Mainly bottle and ocassional breast

please tick

If both, please state number of bottles and breast feeds today

What position did you place your baby to sleep ?

back ....
side ....
front ....
don't know

please tick

Did your baby use a dummy in order to go to sleep last night? *yes/no*

Where did your baby sleep last night ?
Which room and which bed or cot. Please state if in more than one place

What time did you go to bed last night ? ....
What time did you go to sleep last night ? ....
What time did you wake in the morning ?

What time did your baby go to bed last night ? ....
What time did your baby go to sleep last night ? ....
What time did your baby wake in the morning ?

Did your baby sleep well last night ? If not why not eg unwell

How many times did your baby wake during the night ?

How many times did your baby breast feed during the night ?

How many times did your baby bottle feed during the night ?

How many times did you comfort your baby and not feed him/her during the night ?

How many times did you check your baby during the night whilst he/she was asleep ?

Did you use a dummy to pacify your baby during the night ?

What clothes did your baby wear to bed last night
please list the number and type eg vest, babygrower, bonnet, socks etc

What sort and what number of covers were used where your baby slept
eg sheet, blankets, duvet etc

Was the heating on in the room where your baby slept last night ?

Did your baby feel or look sweaty during the night or on waking ?

How would you describe the weather last night ?

Did your baby sleep with you or anyone else during the night at any time ?

For how long?	*please tick*	**Where ?**	**With whom ?**
Less than 2 hours	....	e.g in bed, armchair ?	eg mother, father
2 to 4 hours	....		
More than 4 hours	....		
The whole night			

If your baby woke last night, approximately when and for how long ?

HOME SLEEP LOG

Date

Day of week

Study number

Age
(weeks and days)

What position did you place your baby to sleep ?
back ....
side ....
front ....
don't know

please tick

Did your baby use a dummy in order to go to sleep last night? *yes/no*

Where did your baby sleep last night ?
Which room and which bed or cot. Please state if in more than one place

What time did you go to bed last night ? ....
What time did you go to sleep last night ? ....
What time did you wake in the morning ?

What time did your baby go to bed last night ? ....
What time did your baby go to sleep last night ? ....
What time did your baby wake in the morning ?

Did your baby sleep well last night ? If not why not eg unwell

How many times did your baby wake during the night ?

How many times did your baby breast feed during the night ?

How many times did your baby bottle feed during the night ?

How many times did you comfort your baby and not feed him/her during the night ?

How many times did you check your baby during the night whilst he/she was asleep ?

Did you use a dummy to pacify your baby during the night ?

What clothes did your baby wear to bed last night
please list the number and type eg vest, babygrower, bonnet, socks etc

What sort and what number of covers were used where your baby slept
eg sheet, blankets, duvet etc

Was the heating on in the room where your baby slept last night ?

Did your baby feel or look sweaty during the night or on waking ?

How would you describe the weather last night ?

Did your baby sleep with you or anyone else during the night at any time ?

For how long? *please tick*
Less than 2 hours ....
2 to 4 hours ....
More than 4 hours ....
The whole night

Where ?
e.g in bed, armchair ?

With whom ?
eg mother, father

If your baby woke last night, approximately when and for how long ?

Appendix B

Information Sheet

COT DEATH RESEARCH AND SUPPORT

INFORMATION FOR PARENTS

SHIELD

RESEARCH PROJECT: A STUDY OF MOTHER BABY INTERACTIONS DURING SLEEP

Background

Before birth babies are in a warm, protected environment (the uterus) where all their needs are met by their mothers. After birth babies learn to adapt to the external world, but for many months they remain vulnerable to changes in their new environment such as variations in temperature. From our previous research we have learnt that mothers are generally *very* skilled at ensuring that their babies do not become either too hot or too cold but we do not fully understand how they actually do this, particularly at night when it seems that some babies can be vulnerable.

The Research Project

As part of the research programme being carried out in the new Sebastian Diamond Infant Physiology Unit we have set up a homelike bedroom in which mothers and babies can sleep together. The aim of the study is to learn more about the interactions between mothers and healthy babies during the night.

There will be a brief initial interview about you and your baby's health and you will be asked to keep a "sleep log" of your infants sleep patterns. We will leave equipment that will record the night-time temperature in your bedroom prior to the first study. We would like to perform 5 studies during the first 6 months after your babies birth at approximately monthly intervals. The first study would be for 1 night and the subsequent studies would be for 2 nights each. Your baby will have sensors in place to record breathing, heart rate (ECG), oxygen levels and temperature, together with brain wave (EEG) and eye movement (EOG). All sensors are specially designed to cause no disturbance to normal sleep and activity. You and your baby will also be monitored on camera and video-taped each night. The video camera will only be pointed at the bed and will not be able to view the whole of the bedroom. For one of the nights you will be asked to share the double sized bed with your baby and on the other night your baby will sleep in a cot by the bedside. The temperature of the sleep centre will be altered so as to resemble the temperatures that we find from the recordings taken at your home. Apart from the inconvenience of sleeping away from home we will make every effort to ensure that your usual sleeping pattern is followed as much as possible.

Safety

A doctor or a female nurse will be present in the sleep centre to monitor the recording each night. You will be able to summon their assistance at any time during the night. There are no physical risks to you or your baby apart from possible temporary skin redness where some of the sensors are applied.

Confidentiality

No information that could identify you or your infant, such as videotapes of your sleep, would be released to anyone without your full written informed consent. However anonymous information may be used for teaching purposes or for presentations at scientific meetings. As a matter of courtesy we would inform your General Practitioner of your participation in this study.

Other information

We will only be able to include a small number of mothers and babies.If you are asked to take part in this important study we do hope that you will give it serious consideration. You may wish, of course, to decline to take part or withdraw from the study at any time without giving a reason. If you do not wish to take part this will have no effect on the care that you or your baby are given.

INFORMATION WHEN COMING TO THE SLEEP CENTRE

RESEARCH PROJECT:
A STUDY OF MOTHER BABY INTERACTIONS DURING SLEEP

Normal Sleep You should arrive about 2 hours before your baby usually goes to bed and arrange to be in the Sleep Unit long enough for us to record a normal nights sleep.

Transport We can organise and pay for a taxi to take you to and from the Hospital. If you come by car please note that there is no official overnight parking at St. Michael's Hospital but we can arrange for you to park in the staff car park directly opposite the main entrance. Please then go to the front desk at the hospital and ask for extension 5676. We will come down and meet you.

Night wear Your baby will also need to wear a similar outfit each night.

Nappies. You will need to bring nappies and other baby supplies as we only have a small "emergency" supply!

Bedding We have a down and feather duvet and/or blankets as well as a range of bedding for the cot. You can bring and use any other bedding if you wish.

Bathing There is a shower in the SleepUnit.

Food There are no overnight canteen facilities at St. Michael's Hospital but we have a microwave oven and a toaster in the Unit. We have tea, coffee and biscuits. You should bring any other food or snacks that you will require.

Payment There is no payment for participating in the study but we can reimburse your travelling expenses.

Messages Should you need to be contacted the sleep centre phone number is 0117 928 5676. You can use this phone whilst at the sleep centre.

Video Recordings At the end of the study we would be happy to give you copies of some of the video tape of your sleep!

Other Information If you would like any further information or would like to view the Sleep Centre please contact either of us :

Dr. Andrew Sawczenko (0117) 928 5676
Professor Peter Fleming (0117) 928 5226/5
Department of Child Health
St. Michael's Hospital
Bristol
BS2 8EG

Appendix C

Consent Form

CONSENT TO TAKE PART IN THE STUDY

RESEARCH PROJECT: A STUDY OF MOTHER-BABY INTERACTIONS DURING SLEEP

This is to confirm that I have read the sheet of information for parents about this study and have agreed that I am willing to take part.

I have spoken to .... (one of the research team) who has fully explained the project to me and he/she has given me the opportunity to ask questions. I have also been offered the oppourtunity to visit the Sebastian Diamond Sleep Centre and to see the study bedroom.

I understand that I may withdraw from the study at any time, without giving a reason and that this wil not affect my future care in any way.

I confirm that the above statements are correct and give consent to take part in the study.

BABY'S NAME ....

BABY'S DATE OF BIRTH ....

MOTHER'S SIGNATURE ....

MOTHERS NAME ....

DATE ....

Department of Child Health
St. Michael's hospital
Bristol
BS2 8EG

Appendix D

Personal Details Questionnaire

DATA SHEET

Study number

Date

Mother

Surname

DOB

First name

Age

Hospital number

Ethnic group

Marital status

Phone

Address

Occupation

Currently working ?

Please describe the number of hours and any shift work

Father

Surname

Age

First name

Ethnic Group

Occupation

Currently working ?

Please describe the number of hours and any shift work

Baby

Surname

Date of Birth

First name

Sex

Hospital number

Gestation

Birth complications

Birth weight

OFC

5 minute Apgar

GP

Name

Phone

Address

Mother's Medical History

Did you have any health problems during this pregnancy ?
(eg urine infection, vaginal bleeding, raised blood pressure)

Were you prescribed any medicines, tablets or drugs during this pregnancy ?
(If yes, what where they)

Did you smoke during this pregnancy ?
(If so how many cigarettes/day and over what period)

Did you drink alcohol during this pregnancy ? (If so how much e.g. glasses, of beer, wine, spirits/week and for what period)

Any serious health problems now or in the past ? (please describe)

Are you currently on any prescribed medicines ? (please describe)

How much alcohol do you drink now ?

Do you smoke or have you smoked in the past ? (If so how many cigarettes per day)

Have you ever had any problems with your sleep in the past ?
(eg early waking or difficulty in going to sleep)

At present do you normally sleep well ? (if not please describe any problem)

How often do you not sleep to your satisfaction ? (most nights, one night a week, rarely)

How often are you sleepy or tired during the day ?

Do you nap during the day ? (if so how often and is this regular)

Father's Medical History

Any serious health problems now or in the past ? (please describe)

Smoker ? (now or in the past and if so how many cigarettes per day)

How much alcohol do you drink ?

Baby's Medical History

How are you currently feeding your baby ?
Breast only
Bottle only
Mainly breast and occasional bottle
Mainly bottle and occasional breast
If both, please state number of bottles and breast feeds each day

Does your baby have any health problems ? (eg eczema)

Is your baby on any prescribed medication ? (please describe)

Does your baby have sleep problems ? (eg difficulty falling asleep, abnormal nighttime waking, no regular sleep pattern. Is this a regular problem)

Does your baby have colic (if so at what time of the day and for how long) ?

Other Children

Number

Please state their ages and sex

Did or do any of your children have sleeping problems (if so please describe what sort and at what ages) ?

Please state where they regularly slept, at what age up to 1 year ?
eg 0-3 months, your bedroom, 3-6 months own room, in your bed etc

Are your sleeping arrangements and practices different for your new baby compared to your previous children (if so why) ?

Did you use a dummy with your other children ?

FH SIDS

Has any baby died suddenly or unexpectedly in your immediate or close family ?
If yes Who ?
When ?
What was the cause of death
Where was this ?

HOUSING

Type of house or flat ?

How many bedrooms ?

How many other rooms ? (including bathroom and kitchen)

Type of heating in the bedrooms

Type of heating in rest of house

How many adults are there in the household ? (eg including grandparents)

How many children are there in the household?

Please describe the family's sleeping arrangements ?

Sleeping Arrangements for your new baby

What are the usual sleeping arrangements for your baby ?
(e.g in a cot in parents room, in a cot in separate room, in bed with one or both parents)

If in a separate room :
Can you hear your baby wake during the night ?

Do you regularly check your baby at night (and if so how many times each night) ?

What is the usual sleeping position you place your baby to sleep ? (eg back, side, front)

What is the usual sleeping position that your baby is in when she/he wakes?

How often does your baby spend some or all of the night sleeping in your bed ?
(nights per week)

If you regularly sleep with your baby in bed, did you intend to before the baby was born ?

If you regularly sleep with your baby in bed what are your reasons ?

Any Comments ?

Which of these best describes your view ?
All babies should sleep in bed with their mothers
Many babies are better in bed with their mother
Some babies are helped by sleeping with their mother
A few babies are helped by sleeping with their mother
Babies should not sleep with their mother

Which of these best describes your friend and relatives views ?
All babies should sleep in bed with their mothers
Many babies are better in bed with their mother
Some babies are helped by sleeping with their mother
A few babies are helped by sleeping with their mother
Babies should not sleep with their mother

Appendix E

Study Log

STUDY LOG

Date

Study number

Wt (Kg)

OFC (cm)

Cosleeping

Age
(weeks and days)

Cardas File Start Stop

Squirrel File Start Stop

Video File Start Stop

Video Tapes

Excel files

Squirrel Channels

Baby's clothes

Vests
Babygrowers

Other

Bedding on Cot

Sheets

Blankets

Mother's bedding

Arrival time

Leaving time

Feeds

Baby asleep

Baby in bed

Baby awake

Baby out of bed

Mother in bed

Lights out

Mother awake

Mother out of bed

RECORD OF NIGHT

Time

TECHNICAL PROBLEMS

Time

COMMENTS AND SPECIAL NOTES

Appendix F

The Behavioural Code

Appendix F

The Behavioural Code

This appendix contains the rulcs and shorthand code used in the documentation of night-time mother-infant behaviour and interactions from video recordingss.

<u>Movements and Noises</u>
Shorthand Code:
B Baby   M Mother

Baby movements:		*Baby Noises:*	
Sq	squirm	Gr	grunt
mvt	movement	Squeak	squeak
H	head	C/cry	cry
T	trunk	Yell	yelling/scream/distressed crying
A	arm	Dp Bth	deep breath
L	leg	Sigh	sigh
F	face	Hic	hiccups
h	hand	Burp	burp
feed comm.	feed commenced		
feed stop	feed ended/stopped		
repos	reposition/repositioned		
bed'g	bedding		
tch	touch		

Mother movements:		*Mother noises:*	
mvt	movement	talk	talk
H	head	Dp Bth	deep breath
T	trunk	whisper	whisper
A	arm	sing	singing
L	leg	snore	snoring
F	face		
h	hand		
feed comm.	feed commenced		
feed stop	feed ended/stopped		
repos	reposition/repositioned		
bed'g	bedding		
stretch	stretch		
tch	touch		
Sl.	slight (e.g. sl H mvt: slight head movement)		
rock cot	rocking cot		
off breast	offers baby breast		
off dum	offers baby dummy		
kiss	kiss		
smile	smile		
scratch	scratches body part, (part specified).		
cud	cuddles baby		

Appendix F continued..

Movements and Noises continued..

Rules

- Real time start and stop times, and duration of movement/noise were recorded.
- Movements and noises occurring toether were considered to be separate, discrete events if at least 3 seconds separated the cessation of one and the beginning of another.
- Movements were described with reference to what body part was moving or being moved or repositioned. Unusual or infrequent movement or noises were described in long hand in the column 'what' in reference to baby/mother movements or noises.

Interactions

Rules

- The initiator of the interaction (baby or mother), and the delay time (seconds) were documented, together with a description of what occurred during the interaction.
- The initiator of the interaction was indicated by an arrow pointing in the direction of the member of the pair who responded, e.g. '>' baby initiated; '<' mother initiated.
- Equally initiated or 'simultaneous' interactions were defined as interactions occurring between mother-infant pairs within the same one second time period, with a delay time of less than one second. These interactions were indicated by an '=' sign.
- Breastfeeding episodes were recorded in the interaction section. Breastfeeding episodes began and ended with nipple attachment and detachment respectively, but also included very short interruptions during which the mother changed from one breast to another. These interruptions were very short and within the 30 second time period.
- A new breastfeeding episode was scored if breastfeeding was interrupted by maternal behaviours which indicated an attempt by the mother to terminate feeding, but the infant's refusal to settle prompted the mother to reinitiate feeding, and the new episode commenced at least three minutes after the cessation of the previous episode.

Example of Code: Baby produces a movement and noise lasting 5 seconds which initiates an interaction with the mother in which the mother responds within 4 seconds. Mother looks at baby and pats the baby's back for a duration of 8 seconds.

Baby columns								Mother columns					
St	Stp	Lgt	Mvt	N	What	Init	Delay	St	Stp	Lgt	Mvt	N	What
34	39	5	x	x	Sq	>	4	38	46	8	x		Look at B
													pat back

Distance

Code: The code grouped the distances between mother and infant into 3 bins which were in multiples of 20 cm:

Bin 1: < 20cm
Bin 2: 20-60 cm
Bin 3: > 60 cm

Appendix F continued..

<u>Orientation</u>

Rules:

- Physical orientation and body and head positions of mother and baby were described in relation to each other using a two (2) letter code.
- If mother or baby were not visible 'DK' for 'don't know' was coded.

Code:

Body position and orientation (First letter of 2 letter code):

S supine
P prone
T towards - ventral body surface facing towards other member of the pair i.e. lateral position facing towards mother or baby
A away - ventral body surface facing away from other member of the pair i.e. lateral position facing away from mother and baby

Head position and orientation (Second letter of 2 letter code):

U up; head and face in midline orientation, facing towards ceiling
D down; head and face in midline orientation, facing down
T towards; head and face orientated towards other member of the pair, regardless of body position
A away, head and face orientated away from other member of the pair, regardless of body position

Examples:

Baby orientation:

SU Baby supine, face and head in midline, facing upwards
ST baby supine, face and head facing towards mother
TT baby sidelying with ventrum facing towards mother, with head and face facing towards mother

Mother orientation:

PT mother prone, head and face towards baby
TT mother sidelying, ventrum towards baby, with head and face also facing baby
AA mother sidelying, ventrum facing away from baby, with face and head orientated away from baby

Appendix F continued..

<u>Physical Contact</u>

Code

- Tactile contact between mother and baby was described in relation to which parts of the body were in contact, e.g.

F	face	H	head
T	trunk	B	breast
A	arm/arms	L	leg/legs

- These classifications were left at gross body parts and not subdivided down into 'h' for hands and 'f' for feet.
- The initiator of the tactile contact was also recorded:

'>' mother initiated;
'<' baby initiated;
'=' equal contribution to contact, e.g. during feeds, when baby is actively feeding and mother is offering breast to feed; or during periods when both members of the pair are asleep and in contact, and neither member of the pair moves away.

Examples:

Mum touch	Initiator of Touch	Baby touch	Explanation
BTA	=	FTA	Baby is feeding with his/her face, trunk and arms in contact with mother's breast, trunk and arms.
TA	>	TA	Baby may be being picked up or cuddled by mother with trunk and arms in contact with mother's trunk and arms.
BT	<	A	During baby movement, baby's arm touches mother's breast and trunk.

Rules:

When contact was obscured by bedding for short periods, contact was only coded after consideration of the following criteria:

- There had been prior physical contact and i) body positions remained the same, and ii) head and body distances remained the same or less.
- Proximity of head and/or body was less than 20 cm between the pair; and body position and orientations faced towards each other with/without arms extended toward the other member of the pair
- Bedding position and shape around the mother and baby indicated that touch or pressure was being exerted either through or under the bedding. This included contact which was made when mothers positioned their arms over the bedding and across their infant's body.
- After each movement of mother or baby the coding for any physical contact which was observed was re-evaluated using the above criteria.
- Equal or simultaneous contact was described when there was an equal contribution by both mother and infant to the contact that was made.

Appendix F continued..

<u>Bedding</u>

Code

The type of bedding chosen, the number of layers used and the level to which it was placed on the body were documented.

Baby's bedding:

Type of bedding		Layers of blanket	
D	duvet	B-1	blanket layer x 1
S	sheet	B-2	blanket layers x 2
B	blanket	B-3	blanket layers x 3
		B-4	blanket layers x 4

Mother's bedding:

D duvet
S sheet

Level at which bedding is positioned on the body for both mothers and infants:

1 Bedding covers trunk to shoulder level (neck), both arms under covers;
2 Bedding covers trunk to level of shoulders, one or both arms visible (not covered);
3 Bedding covers trunk to level of mid chest (epigastric) level;
4 Bedding covers trunk to level of hips (umbilical level);
5 Body completely uncovered by any bedding;
6 Bedding completely covered head and body.

Rules:

- The periods of time in which mothers left the bed or room, and were therefore completely uncovered by bedding e.g. changing infant's nappy or visiting the bathroom, were removed from the analysis for maternal bedding.

<u>Sleep State</u>

Rules:

- Observations of sleep state from the video recordings for both mother and baby were recorded onto the behavioural code.
- Maternal sleep states were based on observations of the mother in which each minute of the recording was categorised as to whether the mother was awake or asleep.
- Awake periods were defined when the mother's eyes were open for at least five seconds. These periods were usually accompanied by sustained gross body movements, irregular breathing and vocalisation directed towards the infant.
- Asleep periods were defined when the mother's eyes were closed for at least five seconds, and were usually accompanied by regular breathing, and occasionally snoring. There was an absence of gross body movement, however the presence of twitches and brief head movements were permitted.

Appendix F continued..

Rules continued...

- Where the observer was not certain of sleep/wake state, the period was categorised as 'appears awake', ' appears asleep' or rarely, as 'state not known'.
- Infant sleep staging was performed off line using modified versions of Anders et al (1971) and Stefanski et al (1984) criteria on the recorded physiological data, and replaced the behavioural observations of sleep state made for the infant.

Code for sleep staging based on observations of behaviour:

Mother's sleep state		Baby's sleep state		DK: Don't know (state not known)
A	awake	A	awake	
a	appears awake	a	appears awake	
s	appears asleep	s	appears asleep	
S	asleep	S	asleep	

Baby's sleep state using recorded physiology:

4	awake
3	REM (rapid eye movement) or Active sleep
2	Unknown sleep
1	Quiet sleep

Comments Section

Code:

- The behavioural code contained a comments section which allowed unusual occurrences or events such as thumb, finger or dummy sucking to be recorded.
- The changing of video tapes, technician intervention, a more detailed description of bedding arrangements and mother-infant interactions were also documented here.
- Details of events which did not fall into specific categories in the code were also documented in the comments section in relation to when and how they occurred, to prevent any detail from being lost.
- The observations made in the comments section, although not specifically categorised, were consistently reported for each night of recording and for all subjects.

Note:

The following page of Appendix F contains an example of the data log sheet used to manually code behavioural observations from the video records.

The EXCEL spreadsheet on the computer contained four additional columns (two for infants, 2 for mothers) under the movements and noises section to allow records to be made of separate movements and noises which occurred in the same 30 second time period.

Time	Baby		B	Bby	Bby				Mum		M	Mm	Mm		Dist	Bby	Mum	Mum	Init.	Baby	M.Bed'g		B.Bed'g		State		Comments
	St	Stp	Lgt	Mv	N	What	Init	Dly	St	Stp	Lgt	Mv	N	What		Orien	Orien	T'ch	T'ch	T'ch	Pos	L's	Pos	L's	M	B	

Appendix G

Criteria for Infant Sleep Staging

Appendix G

Criteria for Infant Sleep Staging

<u>*A Scoring System for State of Sleep and Wakefulness in Infants*</u>

In 1971 Anders, Emde and Parmelee published *A Manual of Standardized Terminology, Techniques and Criteria for Scoring States of Sleep and Wakefulness in Newborn Infants* (Anders et al., 1971) as a tool for the guidance of research into the electrophysiologic and behavioural nature of sleep in infants (Sheldon, 1996). There had been a compelling need for a common system for sleep scoring in the infant, as most reseachers had tended to employ diverse modifications of the adult scoring criteria (Rechtschaffen and Kales, 1968). This system classifies each physiological and behavioural observation in a standardized way. Then using an epoch-by-epoch approach to coding, which is often the criterion of one minute, each epoch is assigned a single state score from the coding of the physiological and behavioural parameters. The criteria described by Anders et al. (1971) provides definitions of sleep states which include the coding for all polysomnographic parameters that may be recorded, however allows the individual investigator the flexibility to choose the most useful or appropriate parameters to monitor depending on the purpose of their investigation (Anders et al., 1971). The criteria selected for the scoring of sleep states will therefore vary according to the parameters used. Anders et al. (1971) propose that with rigorous standardized coding of individual parameters, the flexibility in state scoring will not significantly alter the results from different laboratories, and makes the manual most useful to a wide variety of investigators.

Stefanski et al. (1984) have described a scoring system for states of sleep and wakefulness in term and preterm infants which is based on independent assessments of behavioural and EEG patterns. The system for coding infant behaviour is based on observations made in the laboratory by Stefanski and colleagues, and by others (Parmelee et al., 1967; Dreyfus-Brisac, 1970; Anders et al., 1971; Prechtl, 1974), and includes the quality of body and eye movements. Stefanski et al. (1984) use the widely accepted guidelines for recording the EEGs of term infants, published by Anders et al. (1971), however extended the system so that it could also be applied to preterm infants.

Stefanski et al. (1984) exclude the chin myogram and the rates of variabilities of pulse and respiration from their scoring system. The chin myogram is highly variable, particularly in preterm infants (Dreyfus-Brisac, 1970; Parmelee and Stern, 1972) and therefore is not consistently applicable as a criterion for state designation. Heart rate and respiration are excluded because they are often dependent variables in physiologic studies. Stefanski and colleagues (1984) propose that these variables require a framework for interpretation that does not presuppose their occurrence in a particular state of sleep or wakefulness. Code numbers are assigned to the behavioural and EEG patterns, and designation of the infant's state of sleep or wakefulness is then made by combining concurrent behavioural and EEG scores into a single two number code. Because many physiologic variables are conventionally measured on a minute-to minute basis, the epoch length for coding state with this system is 1 minute.

Criteria for scoring infant sleep state in the study of night-time mother-infant interactions

The criteria used for scoring states of sleep and wakefulness for the full term infants in this study were based on modified versions of the two coding systems described by Anders et al. (1971) and Stefanski et al. (1984). The physiological parameters used in this scoring system included the EEG, EOG, ECG, respiratory (chest and abdominal) and video channels. This system used the phase relationship between ribcage and abdominal signals as a marker of intercostal muscle tone, to help distinguish quiet from active sleep. Changes in sleep state were scored if they lasted 2 minutes or more, and arousals of more than two minutes were recorded as awake. For consistency and due to the wide age range of studies (from one to five months of age), only active and quiet sleep were categorised with no sub-division of quiet sleep, as this cannot be reliably performed in infants of 2 months or less (Sawczenko et al., in press).

The criteria for scoring of sleep/wake states in this study were as follows:

Active - REM (Rapid Eye Movement) Sleep:

Active-REM sleep is a state of considerable behavioural activity when the eyes are closed. Periods of quiescence can be observed, but these are overshadowed in time by the infant's large amount of activity. Facial movements consist of smiles, grimaces, frowns, and bursts of sucking. Small digit or limb movements are interspersed with gross body writhing. The movements observed during active-REM sleep are usually slow and writhing in quality, although they may be sudden and jerky.

Rapid eye movements and slow eye movements can be observed under the closed lids. Blinks, penile erections and vocalisations (brief grunts, whimpers and cries) are present. Physiologic measures also reflect marked activity. The EOG is positive for REMS, either singly or in bursts. The EOG is coded positive if a single REM or burst of REMs are present within an epoch. Respiration is irregular with the ribcage and abdominal wave signals out of phase with each other.

The EEG is of the low voltage irregular (LVI), mixed (M) or (rarely) high voltage slow (HVS) pattern. A *low voltage irregular* (LVI) pattern is characteristically of low voltage, quite similar in all scalp regions, and shows little variation during an epoch. The voltage ranges from 14-35 μV, but is generally in the 20-30 μV range. Although the record appears to be dominated by fast theta activity (5-8Hz), there are significant amounts of slow activity (1-5 Hz). A *mixed* (M) pattern consists of both high voltage slow and low voltage polyrhythmic components; these are intermingled with little periodicity. The amplitude is usually lower than that seen with the HVS pattern. The *high voltage slow* (HVS) pattern consists of a continuous, moderately rhythmic, medium to high voltage recording with an amplitude of 50-150 μV and a frequency of 0.5-4 Hz.

Quiet Sleep

Quiet sleep is characterized by behavioural quiescence, regularity of physiological activity and closed eyes. There are no body movements, except for occasional spontaneous startles and episodes of mouth movements. The EOG is negative for REMs. The EOG is coded negative if no REMs are present. Respirations in Quiet sleep are regular, with the ribcage and abdominal wave signals in phase with each other.

The EEG patterns are HVS, tracé alternant (TA) or mixed. The tracé alternant pattern consists of bursts of high voltage slow waves (0.5-3 Hz), with occasional superimposition of rapid low voltage waves and with sharp waves of 2-4 Hz interspersed between the slow waves. These bursts, which have a duration of 3-8 seconds, are separated by 4-8 seconds of attenuated mixed frequency activity. Since high voltage slow and mixed patterns are seen in both quiet and active-REM sleep, only tracé alternant in the former, and LVI patterns in the latter serve to differentiate these states.

Indeterminate or Unknown Sleep

Indeterminate or unknown sleep was scored when certain epochs did not completely meet the criteria for Active-REM and Quiet sleep. In normal newborns, such epochs occur most often at sleep onset, during times when states are changing, and when the infant is arousing. The change from Active-REM to Quiet sleep is much more likely to manifest Indeterminate sleep epochs than vice-versa. Using the criteria for Anders et al. (1971) a single epoch of indeterminate sleep does not necessarily reflect a break in the continuity of a neurophysiological state.

Awake states

Non-sleep or wakeful states in the infant are most reliably judged by behavioural observation. With the present state of knowledge, these states are difficult, if not impossible, to assess by polysomnographic criteria alone; therefore behavioural criteria are commonly used for state determination. Stefanski et al. (1984) describes 3 patterns displayed by the infant when awake including wakeful behaviour, crying and recovery after crying. Anders et al. (1971) divides non-sleep and sleep onset states into crying, active awake, quiet awake and drowsiness. For the purpose of this study these states were grouped under the single heading of 'Awake' and included:

Crying: There is crying vocalization, accompanied by vigorous and diffuse motor activity; the eyes may be open or tightly closed and the face flushed and grimacing. The EEG is of low voltage pattern; continuous 4-7 Hz activity sometimes rhythmic, with voltages predominantly 20-30 uV.

Active awake: Gross body movements are characteristic, and involve the limbs, trunk and neck. The eyes are open and moving. There may be vocalisations and grunting, but the infant does not cry.

Quiet awake: There is relative inactivity. The eyes are open and are bright. The face is relaxed and does not smile or frown. It can be demonstrated that intermittently the eyes fixate and conjugately pursue a slow-moving object for a brief period. Stefanski and colleagues (1984) describe EEG criteria for their Pattern 4 which includes active and quict awakc pcriods: the EEG dcmonstrates immature rhythmic slowing. Monomorphic high voltage (>100 μV) waves of 0.3-2 Hz which often occur in extended sequences lasting longer than 10 secs. They are particularly prominent over the temporal and occipital areas and are often associated with superimposed 10-20 Hz activity ('brushes'). Other activity includes moderate voltage 2-8 Hz waveforms.

Drowsiness: The eyelids are usually open, although they may be closed intermittently. The eyes appear glassy and unfocused. The eyes will not follow a slow moving object. Other characteristics of drowsiness are variable and may or may not include few or no eye movements, or eye movements similar to those seen during active-REM sleep. The infant may be inactive or there may be spurts of writhing activity. The face may be immobile or it may have intermittent smiles, frowns and mouthing activity. During sleep onset, short periods of drowsiness may alternate with Active-REM sleep.

Artifact Time:

The infant's heightened activity and motility may occasionally obscure the polygraphic record with movement artifact. These times are likely to occur during sleep-onset, certain periods of Active-REM sleep, and just before awakening. Vocalisation is often present. The state of the infant may be difficult to determine by behavioural and polygraphic observation. If less than one minute of this activity is present during a sleep period, the previous state was scored as continuous; if more than one minute; it was scored as artifact time.

Appendix H

Intra- and Inter-Observer Reliability Checking

Appendix H

Intra- and Inter-Reliability Checking Report

Design

Reliability checking was performed on eight sleep studies, four of which were originally coded by the author and four by the assistant. Each coder watched and recoded four studies, two of which she originally coded (one at the beginning of the period of coding, and one towards the end of the period of coding) and two of which the other coder had done (again, one at the beginning of the coding, and one towards the end). The recoded sections were compared with the original coding in order to check inter- and intra-observer reliability.

Method

From a list of all the studies originally coded by either coder, two were randomly selected for each observer to recode. If there was not a recent and an older study in the selection, another two studies were randomly selected. Each study was divided into two hour intervals between 0100 and 0600 hours (e.g.: 1:00:00-2:59:59, 2:00:00-3:59:59, etc.). For each study, one of these intervals was randomly chosen to be recoded.

With each study, the original and the recoded versions of the standard coding data were entered on an Excel spread sheet named "studynumber_R". The following statistics were calculated on each sheet: TTests were performed on the length of movements and noises (for mother and baby); the number of movements and noises (for baby and mother); the number of movements or noises which resulted in an interaction; the delay time between the initiator's movement/noise and the other member of the pair's response, and the number of 30 second blocks in which the pair was in physical contact. Mean distances between the heads and bodies of mothers and infants were calculated and TTests on these distances were performed. Mean positions of the bedding for both baby and mum were also calculated, and a TTest performed on the position of the bedding for each. Finally, the start times for movements/noises for both mum and baby were copied into SPSS data files named "studynumber_R", and one-way ANOVA tests were used to identify consistent differences between the original and recoded sections.

Results

Eight two-hour sections were recoded, yielding sixteen hours of original coding data and sixteen hours of recoded coding data. The eight sleep studies used consisted of seven different mother-infant pairs: four routine solitary sleeping pairs and three routine bed-sharing pairs. Five of the studies were on bed-sharing nights and three were on a room-sharing night. All two hour time blocks between 0100 and 0600 hours were represented in at least one study (See Table H.1).

Table H.1 Studies used in Reliability Checking

Study	*Routine*	*This Sleep*	*Time*	*Original Coder*	*Recoder*
01C1	RRS	BN	2:00:00-3:59:59	J	J
02C1	RRS	RN	2:00:00-3:59:59	J	K
05D2	RRS	BN	1:00:00-2:59:59	J	K
06A1	RRS	RN	1:00:00-2:59:59	K	K
06C2	RRS	BN	4:00:00-5:59:59	K	J
07B1	RBS	BN	2:00:00-3:59:59	J	J
09A1	RBS	BN	3:00:00-4:59:59	K	K
10B2	RBS	RN	2:00:00-3:59:59	K	J

Overall, the reliability checking found that the recoding of movements and noises did not differ significantly from the original coding. None of the TTests on lengths of movements or noises (See Tables H.2 and H.3) nor any of the ANOVA tests on start times yielded p-values less than 0.2 (See Table H.4). There were some differences in the numbers of movements and noises coded. The greatest variation occurred during awake periods, where the two coders had slightly different techniques for coding movements/noises and where there was also some variation in each coder's own technique over time. It seems that much of the variation seen in start-stop times and numbers of movements can be explained by differences in where the coder ended one movement (or noise) and began the next during these awake periods.

Table H.2 Reliability Checking of Movement and Noise Data for Infants

Study		*Baby Movements*		*Baby Noise*		*T Test on lengths*
Number	*Column*	*Original*	*Recoding*	*Original*	*Recoding*	
01C1	col. 1	38	42	17	23	p=0.40
	col. 2	4	5	2	4	p=0.30
	col. 3	2	3	2	3	NA
02C1	col. 1	37	53	9	16	p=0.6
	col. 2	6	14	3	8	p=0.86 (unpaired)
	col. 3	0	5	0	1	NA
05D2	col. 1	33	34	14	22	p=0.11
	col. 2	16	9	11	8	p=0.21
	col. 3	6	2	5	2	p=0.57
06A1	col. 1	41	60	20	33	p=0.91
	col. 2	7	7	5	3	p=0.77
	col. 3	0	3	0	1	NA
06C2	col. 1	41	42	27	39	p=0.77
	col. 2	6	6	3	4	p=0.80
	col. 3	1	3	0	3	p=NA
07B1	col. 1	19	20	8	10	p=1.00
	col. 2	4	4	3	3	p=0.39
	col. 3	2	2	0	2	p=1.00
09A1	col. 1	43	47	17	25	p=0.21
	col. 2	3	7	3	5	p=0.33 (unpaired)
	col. 3	1	2	1	2	NA
10B2	col. 1	25	23	34	26	p=0.87
	col. 2	4	9	3	8	p=0.24
	col. 3	2	8	2	7	p=0.46 (unpaired)

Table H.3 Reliability Checking of Movements and Noise Data for Mothers						
Study		*Mother Movement*		*Mother Noise*		*T Test on lengths*
Number	*Column*	*Original*	*Recoding*	*Original*	*Recoding*	
01C1	col. 1	26	26	4	6	p=0.24
	col. 2	9	6	2	6	p=0.23
	col. 3	4	4	1	2	p=0.44
02C1	col. 1	11	12	2	4	p=0.39
	col. 2	2	4	2	4	NA
	col. 3	1	0	1	0	NA
05D2	col. 1	17	19	4	1	p=0.37
	col. 2	2	1	0	1	NA
	col. 3	1	0	1	0	NA
06A1	col. 1	3	5	1	2	p=0.23
	col. 2	0	2	0	2	NA
	col. 3	0	0	0	0	NA
06C2	col. 1	15	15	2	2	p=0.30
	col. 2	2	2	0	2	NA
	col. 3	0	0	0	0	identical
07B1	col. 1	15	17	3	4	p=0.26
	col. 2	2	4	1	4	p=1.00 (unpaired)
	col. 3	1	1	0	0	NA
09A1	col. 1	11	12	0	0	p=0.78
	col. 2	2	0	0	0	NA
	col. 3	2	1	0	1	NA
10B2	col. 1	28	34	9	15	p=1.00
	col. 2	9	15	9	15	p=0.82
	col. 3	8	9	6	7	p=0.30

Table H.4 Reliability Checking of Movement/Noise Start Times by ANOVA Analysis			
Study		*Start Times*	
		Baby	*Mum*
01C1	F Ratio	0.01	0.06
	F Probability	0.92	0.8
02C1	F Ratio	0.36	1.6
	F Probability	0.55	0.22
05D2	F Ratio	0.02	0.13
	F Probability	0.89	0.72
06A1	F Ratio	1.01	0.2
	F Probability	0.32	0.67
06C2	F Ratio	0.06	0
	F Probability	0.81	0.98
07B1	F Ratio	0.02	0
	F Probability	0.89	0.98
09A1	F Ratio	0.52	0.04
	F Probability	0.47	0.85
10B2	F Ratio	0	0.01
	F Probability	1.0	0.93

There were no significant differences in the coding of interactions. The number of interactions coded was quite consistent (identical or nearly so) both between observers and over time for each observer. The author occasionally recorded '=' where the assistant left a blank, but this did not result in a major difference in numbers of interactions in most cases. In no study was the TTest for comparing delay times significant (p > 0.2 in all cases) (See Table H.5).

In most cases, the number of 30 second blocks in which the pair were recorded as touching, or in physical contact, was identical in the original and recoded studies. Where a difference was seen, the author usually coded just slightly more contact than the assistant or than her original coding. The one exception, however, is study 05D2, where the author originally coded 117 blocks (58.5 minutes) of contact, but the assistant recoded only 30 blocks (15 minutes) (See Table H.5).

Table H.5 Reliability Checking of Interaction and Contact Data

Study		*Interactions*		*Contact*	
Number	*Version*	*Number*	*TTest on Delay*	*Blocks*	*Minutes*
01C1	original	28	p=0.35	101	50.5
	recoding	30		105	52.5
02C1	original	7	p=0.51	11	5.5
	recoding	8		8	4
05D2	original	16	p=0.81	117	58.5
	recoding	15		30	15
06A1	original	4	p=0.57	0	0
	recoding	4		0	0
06C2	original	15	p=0.23	35	17.5
	recoding	15		35	17.5
07B1	original	15	p=0.17	240	120
	recoding	15		240	120
09A1	original	12	p=1.00	35	17.5
	recoding	13		35	17.5
10B2	original	22	p=0.09	77	38.5
	recoding	35		87	43.5

Overall, the coding of the time in which babies faced their mother, and mothers faced their baby, was quite consistent. In many cases, the recoding had identical or nearly identical numbers of 30 second blocks where a "towards" position (i.e.: TT, ST, PT, or AT) was recorded. In study 05D2, however, the assistant recoded less towards time for both baby and mum than the author had originally coded. Also, the author and the assistant each recoded one of their own studies with a different amount of towards time for one member of the pair (See Table H.6).

Table H.6 Reliability Checking of Body Orientation Data

Study		*Baby facing Mum*		*Mother facing Baby*	
Number	*Version*	*Blocks*	*Minutes*	*Blocks*	*Minutes*
01C1	original	127	63.5	171	85.5
	recoding	128	64	170	85
02C1	original	89	44.5	134	67
	recoding	93	46.5	130	65
05D2	original	126	63	229	114.5
	recoding	109	54.5	199	99.5
06A1	original	175	87.5	126	63
	recoding	181	90.5	124	62
06C2	original	153	76.5	132	66
	recoding	167	83.5	132	66
07B1	original	240	120	240	120
	recoding	240	120	229	114.5
09A1	original	172	86	198	99
	recoding	171	85.5	198	99
10B2	original	212	106	101	50.5
	recoding	205	102.5	98	49

Some significant differences were seen in the coding of head and body distances between mothers and infants. In over one third of the comparisons, the original and the recoding had identical distances. The author was consistent in the recoding of her own studies, as was the assistant in the case of study 06A1. However, when recoding 09A1, interestingly a study coded toward the end of the coding period, the assistant recorded significantly smaller mean differences in both head and body distances. In the studies originally coded by the author, and recoded by the assistant, the recoding had significantly greater head distances, although body distances were consistent. In the studies originally coded by the assistant, and recoded by the author, the recoding had significantly smaller head and body distances. Hence, there was a discrepancy in the coding of head and body distances, with the assistant tending to record larger distances than the author, particularly for head distances (See Table H.7).

Table H.7 Reliability Checking of Distance and Bedding Data

Study		*Mean Distance*		*Mean Bedding Position*	
Number	*Version*	*Head*	*Body*	*Mother*	*Baby*
01C1	original	1.62	1.08	2.72	2.2
	recoding	1.63	1.11	2.66	2.45
	ttest	p=0.42	p=0.08	p=0.0041	p<0.001
02C1	original	2.97	2.93	1.45	2.6
	recoding	3.0	2.93	1.46	3.11
	ttest	p=0.0045	p=1.00	p=0.72	p<0.001
05D2	original	1.62	1.03	2.09	2.08
	recoding	2.25	1.03	2.13	2.08
	ttest	p<0.001	p=1.00	p=0.01	identical
06A1	original	3	3	1	2
	recoding	3	3	1.01	2
	ttest	identical	identical	p=0.16	identical
06C2	original	2.28	2.28	1.41	2
	recoding	1.81	1.78	1.42	2
	ttest	p<0.001	p<0.001	p=0.08	identical
07B1	original	1	1	3	5
	recoding	1	1	3	5
	ttest	identical	identical	identical	identical
09A1	original	2.9	1.37	1.19	2.15
	recoding	2.68	1.27	1.2	2.12
	ttest	p<0.001	p<0.001	p=0.08	p=0.02
10B2	original	2.72	2.28	2.78	3.25
	recoding	2.66	2.2	2.76	3.15
	ttest	p=0.01	p=0.01	0.25	p=0.03

Bedding position for mothers was quite consistently coded. In 01C1, the author re-coded a significantly lower mean bedding position than the original (2.66 versus 2.72, $p < 0.001$). In 05D2, the assistant recoded a higher mean bedding position than the author's original (2.13 versus 2.09, $p = 0.01$). In both these cases, the mean bedding position differed by less than 0.2, but this amount of variation resulted in a significant p-value for the TTest. In all other comparisons, differences in maternal bedding position were not significant (See Table H.7).

There was slightly more variation in the coding of infant bedding position. In half of the studies, the original and the recoding were identical. Each coder recoded both one of her own studies and one of the other's significantly differently to the original (using $p < 0.05$ as a cut off). In both cases of inter-observer variation, the assistant coded a higher mean bedding position than the author (See Table H.7).

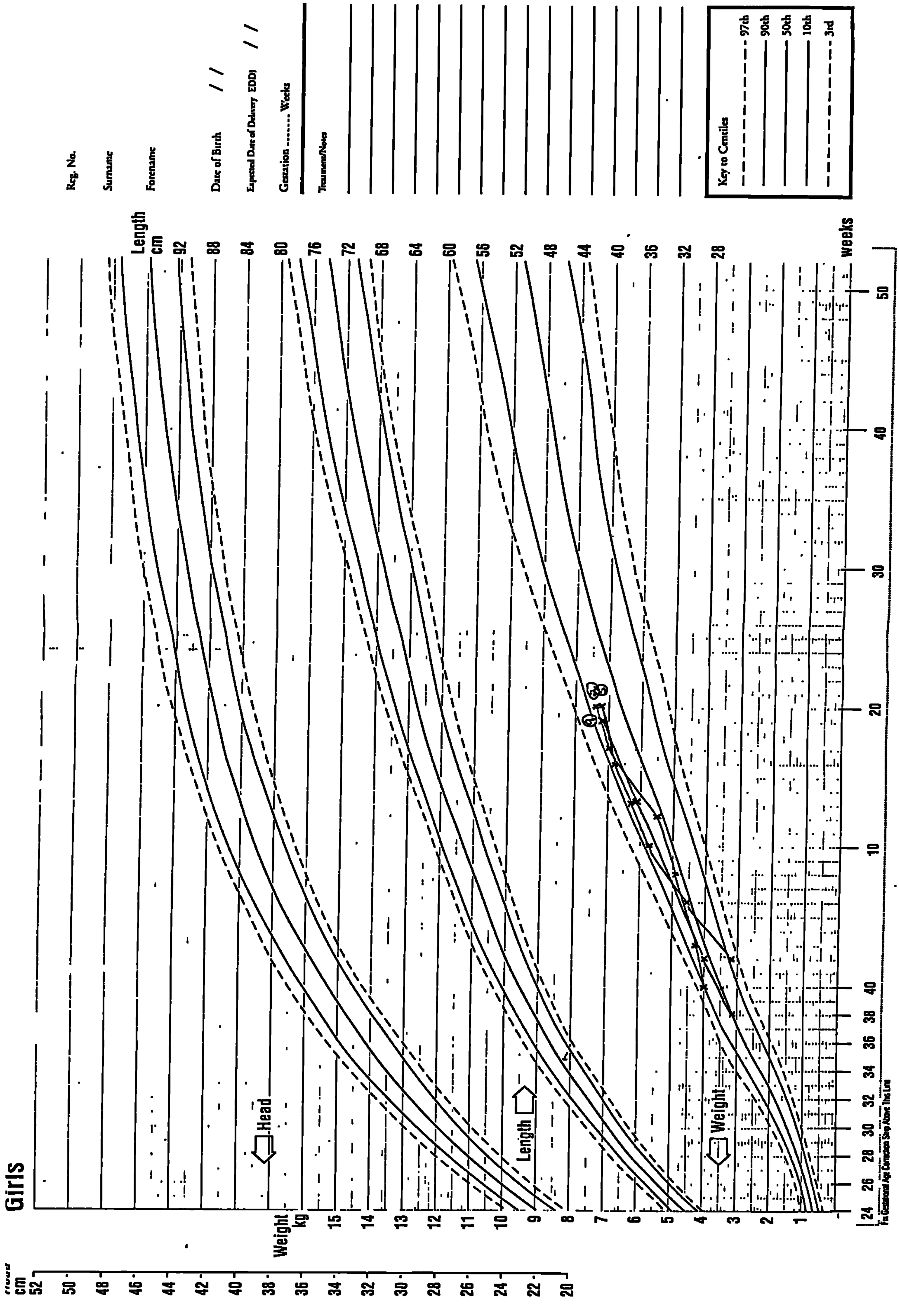
Conclusions

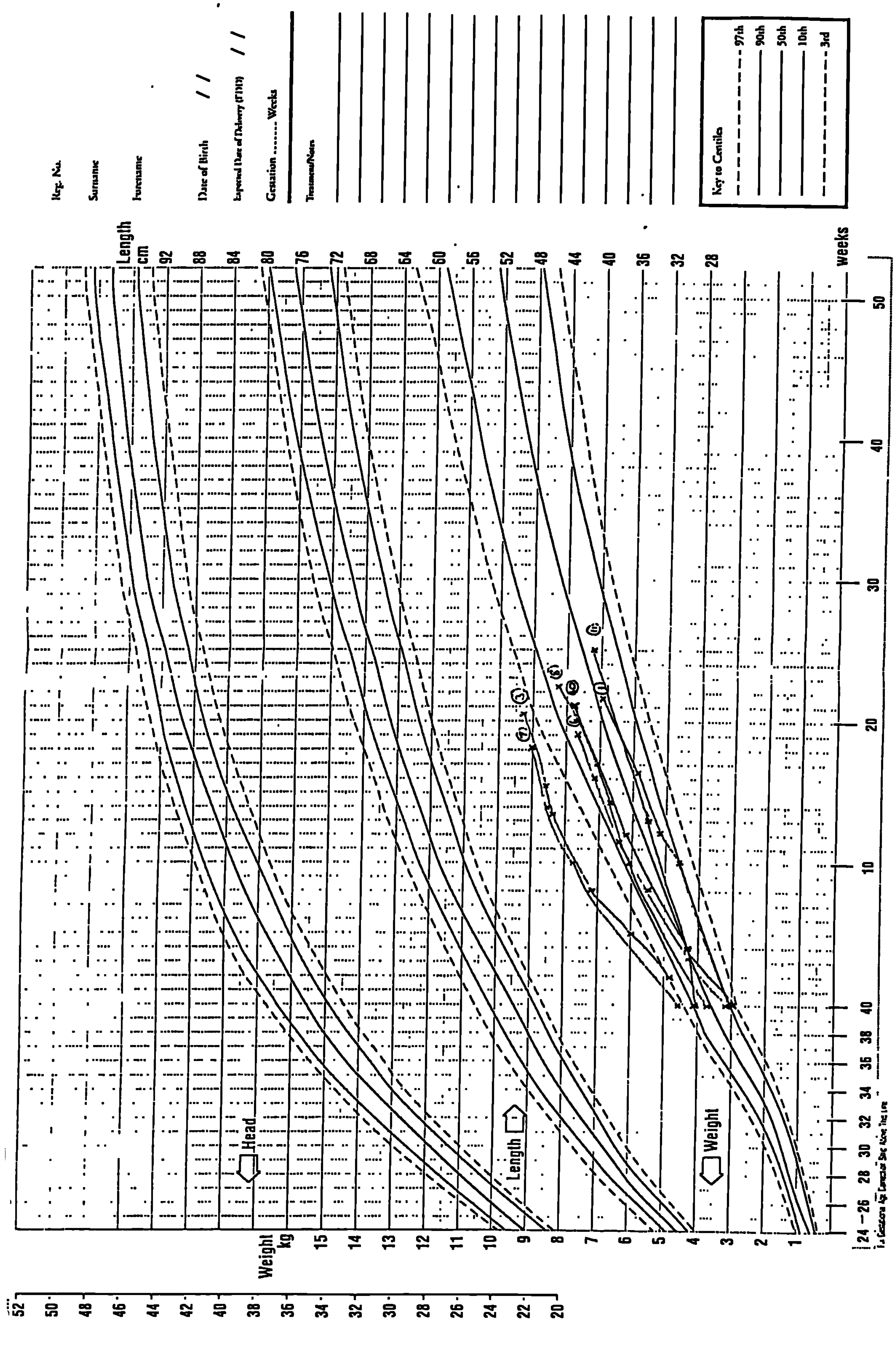
In general, the inter- and intra-observer reliability checking showed that there was very little difference in how a study was coded originally and how it was recoded, using the behavioural code. Although some variation in the coding of awake periods was noted, there were no significant differences in start times, lengths, or delay times for movements or noises. The amount of time the pair was coded as in actual physical contact was also consistent between originals and recodings.

There was, however, a tendency for the assistant to code significantly larger distances between mother and baby, particularly with regard to head distance. There were also a discrepancy in the coding of bedding position, with the author coding lower mean positions than the assistant, and both observers recoding one of their own originals differently. Finally, a few studies showed a trend for the author to record slightly more contact and time facing "towards" than the assistant, although most studies showed consistent coding of these variables. All of these trends should be kept in mind during the analysis of the sleep studies.

Appendix I

Growth and Developmental Charts


Girls
Reg. No.
Surname
Forename
Date of Birth / /
Expected Date of Delivery (EDD) / /
Gestation .... Weeks
Treatment/Notes
Key to Centiles
97th
90th
50th
10th
3rd
Head cm
Length cm
Weight kg
Head
Length
Weight
weeks
For Gestational Age Correction Stop Above This Line



Reg. No.
Surname
Forename
Date of Birth / /
Expected Date of Delivery (EDD) / /
Gestation .... Weeks
Treatment/Notes
Key to Centiles
97th
90th
50th
10th
3rd
Length cm
Head
Length
Weight
Weight kg
weeks

Boys

Appendix J

The McKenna Behavioural Taxonomy

Appendix J

The McKenna Behavioural Taxonomy for Solitary and Co-sleeping Mothers and Infants (January 1995)

Vocalizations

infant vocalizations (i.voc): short, episodic, non-sustained grunts, whimpers, whines, snorts, chortles, chuckles, coughs, sneezes, gasps, wheezes, squeaks, burps, wails, moans, sighs, clucking, clicking, lip smacking.

maternal vocalizations (m. vocs): any sound not directed specifically to her infant including snorting, sneezes, coughs, sighs, grunts, etc.;

infant directed speech (ids): mother speaks/whispers to infant or sings to infant in attempts as if to comfort or reassure as, for example, shh-shh-shh, or dah-dah-dah (see below, non-nursing maternal interventions);

sustained cry: infant cries continuously (no more than 5 seconds passes between cries);

cry-suck-whine (csw): infant whimpers and grunts, and sometimes squeaks simultaneously while sucking its fingers or hands (i.e. is fussy); usually elicits a breastfeeding session.

Body and Facial Orientations, Sleep Position

mother faces infant (mfi): independent of body position mother faces infant;

infant faces mother (ifm): independent of infant sleep position i.e. prone, supine or side, infant faces direction of mother;

mother faces away (mfa): mother not looking toward infant body;

infant faces away (ifa): infant looks away from mother's body;

face each other (feo): mother and infant face each other;

prone: either mother or infant sleeps on stomach

supine: either mother or infant sleeps or is awake lying on back;

side: either mother or infant lies on either side;

arms up (au): mother sleeps with arms above head;

arm or arms up under head (auh): mother sleeps with at least one arm up and at least one hand under head;

Appendix J continued..

knee tuck (kt): mother tucks (abducts) both knees up toward her chest while in bed;

crunch up (cup): mother pulls herself up into a ball while sleeping on her side, usually pulling blankets as she positions herself;

crunch-up with infant (cupi): mother lifts knees up to a position touching the infant feet so that the tops of her thighs are in sustained physical contact with her infant;

enclose (enc): mother passively/loosely positions infant within the space of her arms either during an active behaviour such as breastfeeding, or while they sleep;

legs straight: identified with mother when her legs are straight out.

<u>Sleep / Awake</u>

awake: infant's or mother's eyes are open for at least five seconds;

asleep: infant's or mother's eyes are closed for at least five seconds.

<u>Breastfeeding</u>

nipple mouthing: infant licks or uses its mouth to manipulate mother's nipple or breast;

switch nipple: mother offers other nipple to infant after infant sucking from first;

breastfeeding session: occurs during mother-infant common recording time when mother responds to infant for feeding and the infant establishes nipple contact; the session is said to terminate when contact is broken for more than five minutes;

sucking: infant makes sucking movements and noises as it puts its own fist into its mouth, or its mother's nipple in its mouth;

hand or fist sucking: infant is sucking on its hand or knuckles;

nipple contact (nc): baby on mother's nipple (irrespective of sucking activity) see also infant sleep on nipple;

attempt nurse (attn): infant appears to move toward mother's nipples and mouths nipples before properly in position;

terminate (tn): mother or infant ends nursing session;

off nipple: infant breaks nipple contact;

infant cling: infant actively holds on to mother's body or clothing;

reject nipple: infant turns head back and away from nipple as mother presents nipple;

Appendix J continued..

present nipple: mother unstraps her bra (if necessary) presents nipple to infant;

infant sleep on nipple: appears that infant is finished sucking but remains latched onto nipple after falling asleep (eyes closed), must be at least five minutes on nipple without seeing or hearing any apparent sucking;

<u>Infant Caregiving</u>

non-nursing maternal interventions (nnmi): occur at least five minutes after, and never during, nursing; they are subdivided into two general types: either protective (involving physical management or care) or affectionate, and can occur either spontaneously or in response to infant elicitation, or provocation (a sound, lack of sound after hearing sound, or movement).

Protective NNMI's:
visual inspect: mother leans over infant and looks, or watches or stares, as if making sure infant is safe (but does not touch);
relocating: infant moved either closer or farther away from mother but sleep (prone or supine or side) position is not changed;
repositioning: infant's sleep position (prone, supine, side) is changed by mother;
reblanketing: mother moves the blankets around or near the infant often pulling the infant's (blankets) down off the face, or pulling them up over the infant's face;
redressing: mother rearranges the infants clothing, or changes diaper;
clean nose: mother cleans out infant's nose, often following infant snorting or making a chortling sound;
aerating/fanning: mother fans infant either with hand or blanket as if trying to cool infant off.

Affectionate NNMI's:
embrace/hug: mother spontaneously reduces distance between herself and infant to hold infant between arms, then releases infant momentarily;
kiss: mother kisses baby on some part of body/clothing;
pats: mother repeatedly touches the baby while often simultaneously whispering or speaking to the infant softly;
pounds: mother pats baby assertively so that observer can hear it on the tape;
caress: mother repeatedly massages baby usually on head, back, chest, or hand;
infant directed whispers and songs: may occur independent of physical touching.

<u>Movement Behaviours</u>

scratch: either mother or infant scratches self;

turn away: either partner turns away from facial presentation to the other;

move away: mother moves away from infant without touching infant;

Appendix J continued..

sleep related movements (SRM's): either infant or mother have eyes closed and when movement is detected;

infant induced (II) maternal SRM's: within 5 seconds of the infant moving, mother moves;

maternal induced infant SRM's: within 5 seconds of mother moving, infant moves (arousal overlap);

simultaneous SRM's: mother and infant appear to move at the same time;

carry: mother locomotes out of bed with infant in her arms;

infant flail: infant moving all limbs simultaneously sometimes while vocalizing and head rocking;

infant kick: infant jerks or kicks legs alone or in succession;

head rock: infant moves head to side, usually quickly, once;

head side-to-side: infant rocks head in at least both directions successively and repeatedly;

explore: with eyes open either mother or infant manipulates or appears to play at something in bed, or self;

look around: either mother or infant has eyes open and appears to be looking around environment;

stretch: either partner pushes all limbs out simultaneously, away from body;

jerk: either partner exhibits sudden gross body movement ending abruptly;

twitch: small quivering jerk of hand or limb;

turn about: 360 degree turn by mother over a few minutes;

arch back: infant pushes back away from bed, stretching arms up over head;

watch: either partner appears to be staring at something while eyes are open;

hold hands: mother or infant holds own hands or sleep partner's hands;

touch: mother or infant momentarily, and with apparent purpose touch the other;

touch self: infant or mother touches self momentarily, usually but not always the head or face;

Appendix J continued..

check clock: mother looks back to see time;

passive contact: mother and infant touch without apparent awareness or apparent purpose.

<u>General</u>

technician interference: technician adjusting either partner's leads;

bathroom break: mother goes to bathroom;

call technician: mother calls for technician;

study over: videotape ends;

check clock: mother looks behind her to check time

can't see: can't see baby, usually fully covered with blankets;

common recording time: mother enters bed, co-sleeping study begins.

Note: a comma (,) is inserted to indicate 'same time as' or simultaneity of multiple behaviour units.

Behaviour units may occur alone, in succession, and/or simultaneously, i.e. mother may reposition her infant while patting and singing to it or, mother faces infant while lying supine, infant faces mother while lying supine, while both are in passive contact (touching at the head) and so forth.

Reference:

McKenna, J. (1995b) Behavioural Taxonomy for Solitary and Co-sleeping Mothers and Infants. January 1995. Personal communication with Professor James McKenna, Department of Anthropology, University of Notre Dame, Indiana, USA.

Appendix K

The Durham Behavioural Taxonomy

Appendix K

NORTH TEES NIGHT-TIME INFANT CAREGIVING PROJECT

BEHAVIOURAL TAXONOMY FOR SCORING TRIADIC & DYADIC COSLEEPING

Feeding: breast-bottle feeding behaviours

Start	feeding commences
Stop	feeding terminates
Swnip	switch nipple
Pani, pabot	passive nipple / bottle contact (no obvious signs of sucking / swallowing)
Irni, irbot	infant refuses nipple / bottle (turns had away, clamps lips shut etc)
Iroot	infant roots for nipple / bottle (mouthing / nuzzling movements)
Iattn	infant attempts to nurse (e.g. while mother is asleep)
Iterm	infant terminates feeding (detaches from nipple / bottle, turns away)
Mterm, fterm	mother / father terminates feeding (removes nipple / bottle from infant's mouth)
Mprnip	mother presents nipple (places nipple near or against infant's lips / cheek)
Mprbot, fprbot	mother / father presents bottle (places bottle against infant's lips / cheek)

Caregiving behaviours

Protective Behaviours

Mvi, fvi	mother / father visually inspects infant
mrel, frel	mother / father relocates infant (lifts infant entirely and replaces)
mrpo, frpo	mother / father repositions infant (drags or pushes infant's whole body or limbs)
mrbl, frbl	mother / father reblankets infant (repositions covers over infant)
mrdr, frdr	mother / father redresses infant (removes and replaces clothing)
mcl, fcl	mother / father cleans infant (self explanatory)
mfan, ffan	mother / father fans infant (with hand or covers attempts to cool infant)
mac, fac	mother / father adjusts covers (slightly moves covers up or down infant's body)
map, fap	mother / father moves pillows away from infant (pushes pillows away from infant's head / face)

Appendix K continued..

Caregiving behaviours continued..

Affectionate Behaviours

mhug, fhug	mother / father hugs infant
mkiss, fkiss	mother / father kisses infant
mpat, fpat	mother / father pats infant
mpou, fpou	mother / father pounds infant on back (e.g. to 'wind' infant)
mcar, fcar	mother / father caresses infant
mwh, fwh	mother / father whispers to infant
mhh, fhh	mother / father holds hands with infant
mtou, ftou	mother / father touches infant (e.g. momentarily places hand on chest, head etc.)
mstr, fstr	mother / father strokes infant
mch, fch.	mother / father hold infant on chest (in ventro-ventral position)

Movements

mta, fta, ita	mother / father / infant turns away (from whoever they were previously facing)
mma, fma, ima,	mother / father / infant move away (from whoever they were previously close to)
mti, fti, itm, itf	mother /father turns towards infant or infant turns towards mother/ father
mmi, fmi, imm, imf	mother /father moves towards infant or infant moves towards mother/ father
msrm, fsrm, isrm	mother / father / infant sleep related movement
mca, fca	mother / father carry infant (out of bed, walking around)
ifl,	infant flail (arms)
iki,	infant kick (legs)
ihr	infant head rock
isl	infant slaps (qualified by object -- covers, bed, mother etc)
iex	infant explore / play
ilook	infant looking around
mst, fst, ist	mother / father / infant stretch
mjk, fjk, ijk	mother / father / infant jerks (involuntary 'jump' (whole body) in sleep, may or may not cause subject to wake)
mtw, ftw, itw,	mother / father / infant twitch (involuntary movement of limb(s) as opposed to whole body)
iarb	infant arches back

General behaviours

Mdu / fdu	mother / father 'inserts' dummy
msc, fsc, isc	mother / father / infant scratches themselves
mwa, fwa, iwa	mother / father / infant watching (qualified with object being watched if attribution possible -- eg fwatv = father watches tv, mwai = mother watches infant)
mya, fya, iya	mother / father / infant yawns

Appendix K continued..

General behaviours continued..

mbb, fbb,	mother / father bathroom break (leaves field of view of camera)
ioos	infant out of sight (e.g. taken away for nappy changing)
mret, fret, iret	mother / father / infant returns

Sleep 'states'

mslp, fslp, islp	mother / father / infant asleep
maslp, faslp, iaslp	mother / father / infant appears asleep (eyes closed, no movement for 3 minutes)
fpawk, mpawk, ipawk	mother / father / infant passive awake (eyes open / periodicaly open and closed)
mawak, fawak, iawak	mother / father / infant active awake (eyes open, moving around)

Location of infant in bed

Betw	infant located between parents
Outm	infant located on outside of mother
Outf	infant located on outside of father
Mbed	infant in middle of bed (father absent)
Onm / onf	infant lying on mother / father

Orientation

mfi, ffi	mother / father facing infant
ifm, iff ifn	infant facing mother / father / neutral
mfa, ffa	mother / father / infant facing away (infant can face 'away' from mother when father absent from bed, or infant on outside of mother)
mfn, ffn	mother /father facing neutral (neither one side or other)

Proximity

To	touching (physical contact between any part of infant's body and any part of parent's body)
>4	closest parts of infant's and parent's bodies less than 4 inches (10cm) apart
4-8	closest parts of infant's and parent's bodies between 4 & 8 inches (10-20 cm) apart
<8	closest parts of infant's and parent's bodies greater than 8 inches (20cm) apart

Sleep position (recorded for all subjects)

Pr	prone (sleeping on stomach, face down or to the side)
Su	supine (sleeping on back, face up or to the side)
Si	side (sleeping on side, curled up or straight)

Appendix K continued..

Position of arms (recorded for mother and father)

Ad	arm(s) down
Au	arm(s) up
Auh	arm(s) under head
Enc	arm(s) encircling infant

Position of legs (recorded for mother and father)

Kt	knee tuck (legs bent but obtuse angle between trunk & femur)
Cup	curled up (legs drawn up to trunk making acute angle)
Cupi	curled up round infant (parent's legs generally drawn up to touch infant's feet)
Ls	legs straight

Height of infant relative to mother and father, infant face level with

Eye	mother's / father's eye level
Chn	mother's / father's chin / shoulder level
Cht	mother's / father's chest
Wst	mother's / father's waist

Direction of infant in bed

Use clock positions, 12 = vertical between mother and father
11/1 = tilted slightly to left or right
10/2 = tilted markedly to left or right
9/3 = horiztonal in bed relative to parent(s)

Height of covers for mother, father, infant:

Ank	covers at ankle height
Kn	covers at knee height
Wst	covers at waist height
Cht	covers at chest height
Chn	covers at chin height
Ohd	covers at overhead height
Otc	infant lying on top of covers
Off	covers pushed off, below feet level

Reference:
Ball, H., Hooker, E. (1999) Durham Behavioural Taxonomy for Co-sleeping Mothers, Fathers and Infants. March 1999. Personal communication with Dr Helen Ball and Elaine Hooker, Department of Anthropology, University of Durham, England.

Data-sheet for the Durham Taxonomy

Column 1	Study num	Study number – 1st 2 letters of baby's last name plus DOB, e.g. BA020297
Column 2	e-time	Elapsed time since beginning of tape, hh:mm:ss
Column 3	r-time	Real time on tape, hh:mm:ss
Column 4	feed	Breast-bottle feeding behaviours, to include: start, stop, swnip, pani, irni, iroot, iattn, iterm, mmterm, mprnip
Column 5	care	Caregiving behaviours, to include: mvi, fvi, mrel, frel, mrpo, frpo, mrbl, frbl, mrdr, frdr, mcl, fcl, mfan, ffan, mhug, fhug, mkiss, fkiss, mpat, fpat, mpou, fpou, mcar, fcar, mwh, fwh, mhh, fhh, mfou, ffou, mch, fch.
Column 6	move	mta, fta, ita, mma, fma, ima, msrm, fsrm, isrm, mca, fca, ifl, iki,ihr, iex, ilook, mst, fst, ist, mjk, fjk, ijk, mtw, ftw, itw, mta, fta, ita, iarb.
Column 7	general	msc, fsc, isc, mvi, fvi, mwa, fwa, iwa, mbb, fbb,
Column 8-10	sleep state	mslp, fslp, islp, maslp, faslp, iaslp, fpawk, mpawk, ipawk, mawak, fawak, iawak,
Column 11	place infant	betw, outm,outf.
Column 12-14	orientation	mfi, ffi, ifm, iff, ifn, mfa, ffa, mfn, ffn
Column 15-16	proximity	to, >4, 4-8, <8 (all in inches)
Column 17-19	position	pr, su, si
Column 20-21	arms	ad, au, auh, enc
Column 22-23	legs	kt, cup, cupi, enc, ls
Column 24-25	height	height of infant relative to mother and father, infant face level with: ey, chn, cht, wst
Column 26	direction	direction of infant – clock positions, 12 = vertical between mo & fa
Column 27-30	covers	height of covers for mo, fa, in: ank, kn, wst, cht, chn, ohd

Appendix L

Hospital Policy for Bed-sharing with Babies

Central Sheffield University Hospitals NHS Trust

JESSOP HOSPITAL FOR WOMEN

Babies sleeping in Mothers' Bed whilst in hospital

PROTOCOL

Definition:

Babies sharing their mothers bed while she sleeps either to breastfeed or to receive comfort and warmth - to help baby settle.

References:

1. McKenna J, Mosko S. Sleep and arousal, synchrony and independence, among mothers and infants sleeping apart and together (same bed): an experiment in evolutionary medicine. Acta Paediatr Suppl 1994; 397: 94-102.

2. Klonoff-Cohen H, Edelstein SL. Bed sharing and the sudden infant death syndrome. British Medical Journal 1995; 311: 1269-1272.

3. Fleming PJ, Blair PS, Bacon C, et al. Environment of infants during sleep and risk of the sudden infant death syndrome: results of 1993-95 case control study for confidential inquiry into stillbirths and deaths in infancy. British Medical Journal 1996; 313: 191-195.

Aims / Philosophy:

1. To encourage successful breastfeeding and a close bond between mother and baby within a safe environment.

2. To avoid use of supplementary feeds of formula milk for unsettled breastfed babies.

3. To provide support and guidance to the mother to allow her to make a fully informed choice.

4. To be sensitive to the emotional and physical needs of the mother and her family.

Requirements:

Meshed cot sides.
Cotton sheets and blankets (not duvets).

Appendix J continued...

Indications:

1. Mother's request

2. Babies who are unsettled in their cot or wishing to feed frequently when mother is tired.

Contraindications:

1. Mother ill and unable to care for her baby.

2. Mother sedated, i.e. following intra-muscular pain killers following Caesarean Section.

3. Mother very obese.

4. Maternal or infant pyrexia.

5. Mothers who smoke.

Guidelines:

1. Ensure baby is attaching well to breast (see JHW Breastfeeding Protocol).

2. If mother using duvet, remove and replace with cotton sheets and blankets.

3. Place cot sides on either side of mother's bed to prevent baby falling out of the bed.

4. Ensure mother has easy access to call system in case of difficulty getting out of bed.

5. **Parents must be warned of the dangers of smoking, drinking alcohol, or taking illegal drugs and bed sharing for when they are discharged home.**

SA, April 1997.

Glossary

Electroencephalogram (EEG):
A recording of the electrical activity of the brain by means of electrodes placed on the surface of the head. Data obtained by EEG combined with chin muscle EMG and EOG provide the basis for sleep stage scoring. Electrodes are placed according to the International 10-20 System. A central region electrode (C3 or C4) is referentially recorded as the standard elcctrodc dcrivation from which state scoring is done. (Sheldon et al., 1992, p. 242)

Electrooculogram (EOG):
A recording of voltage changes resulting from changes in position of the globes of the eyes. Each globe is a functional dipole with an anterior (corneal) positive potential and a posterior (retinal) negative potential. The EOG, combined with the EEG and chin muscle EMG, provides the basis for sleep stage scoring. Sleep recording in humans uses surface electrodes placed near the eyes to record the incidence, direction, and velocity of eye movements. (Sheldon et al., 1992, p. 242)

End-tidal carbon dioxide:
Carbon dioxide value of exhaled air, usually determined at the nares by an infrared carbon dioxide analyzer. The value reflects the alveolar or pulmonary arterial blood carbon dioxide level (Sheldon et al., 1992, p. 242).

Ontogeny:
The history of the development of an individual from the fertilised egg to maturity (Martin, 1990, p. 482).

Polysomnogram:
The continuous and simultaneous recording of multiple physiological variables during sleep. Typical parameters continuously monitored include the EEG, EOG, EMG, ECG, respiratory airflow (nasal and oral), respiratory efforts (chest and abdomen), oxygen saturation, and leg movements (Sheldon et al., 1992, p. 245).

Pulse Oximeter:
A method for measuring changes in oxygenation during sleep. This non-invasive technique involves spectrographic analysis of light transmitted through a digit or ear lobe (foot or hand in the case of small premature infants). Oxygenated haemoglobin absorbs light within a relatively narrow spectral range. When deoxygenated haemoglobin absorbs more/less of the transmitted light, this change in absorption can be converted into an analog or digital output signal. Advantages of pulse oximetry are many. Ease of application of the probe, lack of invasiveness of the procedure, relative high sensitivity and specificity, and low cost make it a desirable method of continuously measuring oxygen saturation. (Sheldon, 1996, p. 36-37).

Glossary continued..

Phylogenesis:
The evolutionary history of a species or individual. Adjective: phylogenetic. (Martin, 1990, p. 537).

Quiet Sleep:
Non Rapid Eye Movement sleep (NREM) in infants (and animals) whose specific NREM sleep Stages 1 to 4 cannot be determined. Early in infancy a tracé alternant EEG pattern characterises quiet sleep. (Sheldon et al., 1992, p. 245).

Rapid Eye Movement Sleep (REM sleep):
A stage of sleep with highest brain activity, characterised by enhanced brain metabolism and vivid hallucinatory imagery or dreaming. Spontaneous rapid eye movements occur, resting muscle tone is suppressed, and awakening threshold to nonsignificant stimuli is high. The EEG reveals a relatively low-voltage, mixed-frequency background with notched theta activity ('sawtooth' waves). REM sleep occupies approximately 50% of a newborn's total sleep time. This decreases to approximately 20% to 25% of the total sleep time by 3 to 5 years of age and persists at this level throughout adulthood. REM sleep is also termed paradoxical sleep and active sleep. (Sheldon et al., 1992, p. 245).

Sleep Stages:
Distinctive stages of sleep, best determined by polysomnographic recordings of the EEG, EOG and EMG. (Sheldon et al., 1992, p. 247).

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